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The Effect of Music Listening Technology on Music Discovery

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Abstract

From the phonograph to the CD player to the internet, music listening technologies have significantly affected how people discover music. The goal of this project is to investigate these affects and use the information we obtain to create a plan for an optimal music discovery service. We implemented a journal study and a survey to gather information about listeners' music discovery habits.

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Executive Summary

Background and Objectives

With recent advancements in technology, the way we listen to and discover music is rapidly changing. This has been the case throughout history. With the introduction of the phonograph in 1877, listeners no longer had to listen to music live, because they could listen to recordings on the phonograph. While the device had its shortcomings, it was the first major device that allowed artists to spread their music to large populations, promoting more widespread discovery of music. The next major invention was radio in 1920. The radio was different from the record player in that the listener didn't have as much choice over what they were listening to. While they could listen to whatever station they pleased, the music on that station was up to a DJ on the other side of the broadcast. This made discovering music on the radio more of a passive experience than an active one.

The next major devices were portable listening devices. The first device in this category was the transistor radio, invented in the 1950s. Listeners could now take their music experience on the go. After this, in the 1980s, the portable cassette player came about, allowing listeners to take the music they chose along with them, rather than being at the mercy of a radio DJ. This, along with the fact that cassette tapes could be easily copied and recorded, led to a boom in the underground music scene, allowing listeners to discover artists previously hidden from the public eye. The two main devices after the cassette player were the CD player and mp3 player. CDs brought music into the digital age, and with that, some distinct advantages. The first, and most important was that CDs could be "ripped" with the use of a computer, and then

shared or copied with other people. With the advent of the Internet this sharing became much more common. Other advantages included increased durability over tapes. The final device in this long lineage is the mp3 player. This allowed users to store small files on a device and play the songs back without ever having to change CDs or tapes. These devices could hold thousands of songs, and led to people being able to bring much of their library with them, and share it with anyone around them if they pleased.

Our project aimed to put the current crop of devices and services into the same perspective as those historic devices we talked about. These devices and services we focused on included smartphones, tablets, computers, Pandora Radio, Spotify, Youtube, iTunes, and others. The main goals of our project were to examine the following:

- How do these devices and services affect the way we listen to and discover music, relative to other devices?
- Which of these new devices and services are the most effective at discovering new music, and why?
- To create a plan for a potential future music listening discovery service.

Methodology

In order to fulfill the goals for the projects, various methods of research, study design, and data collection were employed. Through literature reviews of other studies of music, we were able to come up with two main methods of data collection for our study.

The first method was a small-scale study with the use of journals. This study allowed us to collect in-depth data from a small group of people. We designed the study to be done over a 3-week period. Over this period the participants would carry a journal with them, and write down specific information every time they heard a new song. This information included the time of day, the genre, device used, what they were doing while listening, and service used. The goal of these questions was to get an understanding of exactly what people were doing at the precise time of discovery. The study population was comprised of 20 individuals, and in the end we received 8 journals back. This study was mainly to be used to compare and contrast to our other method of research, a survey.

Our survey asked 16 questions, the first 3 about the demographic of the respondent, while the other 13 were about the respondent's music listening and discovering habits. These questions ranged from simple questions like "How many hours of music do you listen to in a typical week?" to "How often do you use the following devices to listen to music?" These types of questions were primarily slider questions. This type of question allows the user to drag a slider from a minimum value to a maximum value and anywhere in between. For the types of questions we asked we thought it would be useful to have an average value rather than a multiple choice answer of which device was preferred or a ranking of devices. This allowed us to do a more in depth analysis where we could compare the average values of each answer for ourselves and even compare them to other questions.

Analysis and Results

We analyzed the data using three primary methods: histograms, variable axes, and frequency plots. Frequency plots were helpful so that we could determine, for example, which service was used more for discovery in comparison to another service. Histograms allowed us to compare the effectiveness of certain discovery types, for example, we could plot each instance of an active discovery and each instance of a passive discovery and compare the distributions. Finally, the variable axes technique allowed us to compare individual journal participant's habits so that we could tell which participant had used which devices or services.

When comparing the data from our two studies we found that the data was relatively consistent and that often the results from the survey were an extension from the results of the journal study. For example the most effective discovery device according to the journal study was the computer whereas the rest of the devices were not effective. According to the results from the survey, the computer, the smart phone and, and the radio were effective devices. This is probably due to the fact that the journal study didn't have as large of a sample size.

We found similar results for the most effective services. In the journal study Spotify and YouTube were the most effective discovery services. The survey data indicated that the most popular services were Pandora, Spotify, YouTube, and ITunes. Once again, the survey data was an extension of the journal results.

The results differed slightly when we studied the most popular and most discovered genres between the two sets of data. The journal data revealed that pop music and electronic music were the most popular and were discovered more often however the other less popular genres were more effective for discovery. The two most popular genres of the survey study

were rock and pop and discovery was also more effective in less popular genres such as hip-hop/rap.

The most effective activity while discovering music was leisure/relaxation. We also found that discovery is not as effective when people are engaged in an activity. The other most common activities were homework, work, and housework. Most discoveries were made while doing another activity, or passively, however we found that active discoveries were much more effective.

Other results included that people discover a new song about every three hours they listen to music, that discoveries made alone are more effective, and that new streaming services have made music discovery easier and more effective.

Conclusions and Recommendations

The greatest effect modern music listening technologies have had is that they have made music libraries infinitely large. This created the need for music discovery services to find favorable music for people that enjoy different types of music. These services which now function as a virtual listening medium are therefore an effect of modern music listening technology. These types of programs exist in popular music services such as Spotify, Pandora, YouTube, and ITunes but they are not perfect. Through our research we believe we have created a template for what would be the optimal music discovery service. This service would include features from all of these popular services such as a radio feature, playlists, videos, and the ability to purchase your own music. It would also contain some unique features based off of our research such as one touch saving of songs, connectivity to all social media networks, and a

unique recommendation feature. With future studies that could delve into specific features, programming aspects, user interface, and a wider audience this program could become a reality.

1 Introduction

The evolving nature of music discovery is a result of the constant growth of technology. In this project our intent was to explore the evolution of music listening devices and analyze the effect they have had on music discovery. The scope of our study will include the record player, radio, tape players, CD player, mp3 player/iPod, online radio, and streaming services. Of particular interest is how modern devices and software, primarily streaming services and music on the web, affect our main theme. This area of study is relatively new with the introduction and popularity of online streaming services and digital music. Consequently there hasn't been as much research on these newer services compared to some of the older music listening devices. In our report we will outline some of this research to give a good background for the type of research we based our study off of. This will be a brief history on the older devices and the effects they've had on music discovery but will also cover some of the newer technologies that we are looking to study.

Then, we will explain our study and why we chose the methods we used. Our study was broken up into two parts, a survey, and a journal study. The goal of the survey study was to obtain a wealth of information so that we could make general claims about the topic. The journal study's aim was to be more intimate such that we could make claims about individual users. Since this study took place in the present day, the conclusions that we made were mostly on modern devices. Although the questions that we asked did include older listening devices such as the record player and cassette player, there was not a huge response rate for these devices.

Our study aims to reveal the average consumers music listening trends, specifically regarding music discovery. We look at how many different factors such as genre, device usage, service usage, and listening habits contribute to the music discovery patterns of people as a whole. We anticipate that music service giants Spotify, and Pandora will play a huge role in our study. We know that they are widely popular but we want to know if they are effective in terms of musical discovery. We suspect that these new services have made music easier to discover since enormous libraries are now available to anybody with an internet connection. With our results we hope to form a plan that will outline a potential music service, or part of a music service, that will thrive in music discovery. This plan could aid businesses looking to further develop modern music listening software or devices with these themes in mind.

2 Background Research

Throughout the course of history many clever inventors have created devices that change the way we, as humans, live. One of the aspects of our culture that has changed drastically due to technological advancements is the music we listen to. Before devices that could record and playback audio the only way to experience music was at a live performance. One can imagine then that the first device that could record and playback sound would have a tremendous effect on music and the music industry. This device came in the form of the phonograph created by Thomas Edison. This device remained the dominant form of music listening for about a hundred years, its only competitor being the radio. Although the radio did not overtake the phonograph, it was a worthy competitor and would also stand the test of time as we still use it today. The next technological breakthrough came in the ability to record on magnetic tape. There were many variations of this technology the most significant of which was the cassette player that gave the consumer the means to listen to their music virtually anywhere they wanted. With the rise of digital technologies compact discs became the leader of the music listening technologies. CD's provided a more convenient form of portable listening doing away with some of the hassles that came with cassette tapes. With the rapid evolution of computers and the internet, music became available online. Multiple programs were, and still are, developed to maximize the use of music on the web. Services such as Napster, ITunes, YouTube, Pandora, Spotify, LimeWire, Groove Shark, and others bring music to the consumer in many different ways from illegal downloading/file sharing, to streaming. Mp3 players and IPods became the dominant technologies because they made use of this new software. When the internet was brought to cellular devices with smart phones, this software became available

without the need for a computer. All of the technologies I've described have had an enormous effect on music in one way or another. With this study we aim to focus on one of these effects, music discovery.

Music Discovery

Although the means at which we discover music has changed the definition of music discovery remains very simple: how we as listeners find new music to listen to. This includes any new music you hear regardless of whether or not it suits your taste or if you will ever listen to it again. We will refer to this as non effective discovery. On the other hand effective discovery is that which will lead to music that you enjoy and will listen to again. Although this study will primarily deal with effective discovery, as it is most useful for our purpose of developing an idea for the next music discovery platform, there will also be occurrences of non effective discovery. There is also active and passive discovery. Active discovery is when you consciously make a decision to find new music or listen to a device that could result in the discovery of new music. This can include searching through libraries for new music, browsing the "discover" page of Spotify, and listening to any form of radio. Passive discovery is when you hear new music by chance, for example you're watching television for leisure and an advertisement plays with a song you haven't heard before. Both active and passive discovery happen within effective and noneffective discovery however one might argue that effective discovery is more prevalent in active discovery and non effective discovery is more common in passive discovery. This will be one of the correlations we look at in our study. As technology has developed, these different styles of listening have emerged. We will now take a closer look at

the specific technologies we have already introduced and examine their effects on music discovery.

Phonograph

In the 1800s if you wanted to listen to music you only had one option, to go see a live performance at your local concert hall. This is also your only option if you want to discover new music. The likelihood of seeing new artists was also pretty low because most artists didn't tour meaning the only music was produced by local acts that play at the same venue multiple times. An artist's reputation might spread and you might hear about them from a friend but the only way to actually experience the music is to go see them for yourself. Sheet music was also in circulation, but to replicate this music requires you to be able to read sheet music and also be able to play the music correctly and even then you're merely replicating the notes on the paper not necessarily the artist's style or tone. This would all change when Thomas Edison invented the phonograph in 1877 (Coleman 2003). As the phonograph was popularized and made affordable music discovery was made easier. Whether it was reproduced with a cylinder or a record, music had become transferable. Musical artists could now have their music spread to a wide audience. If they were popular enough their music could be delivered across the country or even across the world. This means that the consumer was not trapped to listening to the small range of music that was offered at their local concert hall; they could now branch out and buy new music from artists that they've never heard of and genres that might not be popular in their area. For example, one particular European man, Darius Milhaud enjoyed jazz music recorded by black musicians from the 1920s. He writes "Thanks to the phonograph, I will be able to play the discs of black music…that I brought back from the United States" (Katz 2010,

pg. 18). This man could now play this music in Europe and expose it to a whole new audience allowing it to be discovered by more people thousands of miles from the music's origin. This, like many other effects caused by the phonograph, proved to set a precedent for all music listening devices to come.

Music discovery really picked up when it was popularized with the advent of coin-operated phonographs. Naturally people tried to use the record player commercially to make a profit. In 1889 an inventor named Leon Glass created a device that allowed the phonograph to be coin-operated (Coleman 2003). The first penny phonograph was placed in the Palais Royal Saloon. The phonograph would come with pre recorded cylinders and play them when the operator provided the coins. These were introduced when the phonograph wasn't the center of every living room as they were still expensive so it garnered a lot of attention and was very popular. In the first six months of operation, the first fifteen coin operated phonographs generated over four thousand dollars (Almind 2009). Now that music was more accessible and was in a social setting, passive musical discovery became more abundant. More and more of these devices were put into circulation every year and they evolved over time eventually culminating in the jukebox. A little later they would spawn an event known as the dance craze in the 1910s. People would go out to these social settings to listen and dance to music from these devices. They drew in large crowds and greatly increased the popularity of the record player and music in general. Subsequently sales of record players grew tremendously. As Coleman notes, "in 1914, there were eighteen companies in the business of recorded sound; by 1918, there were 166" (2003, pg. 24). This increase in popularity was in large part due to the coin-operated phonograph and the dance craze. It brought music to the mainstream audience,

spurred pop music, and consequently aided music discovery. By 1918, almost every average household had a record player and thus almost every household was playing and discovering new music.

The phonograph opened the door for new musical discoveries but at the same time it had its limitations. For instance, early phonographs had trouble recording certain frequencies. If the pitch of the sound was too high or too low it could not be recorded or would come out muffled, not suitable for a record (Katz 2010). For this reason bass players and keyboard players could not record effectively and were sometimes replaced in certain types of music. Katz points out that "Banjos often substituted for keyboards and early jazz pianists chose to make player piano rolls instead, probably because their sound was so much clearer and more immediate when heard through the gauze of recording"(2010, pg. 91). For some, this limitation was a blessing, for instance tenor vocalists could fit their full range in the recording spectrum. Enrico Caruso, an opera tenor, prospered during this era because his voice recorded admirably. Coleman states that "Caruso's voice was perfectly suited to the talking machine… His voice emerged from the horn with clarity and power, drowning out some of the surface noise" (2003, pg. 19). The same was true twenty years later but for the jazz trumpet playing of Louis Armstrong. Coleman continues, "Just like Enrico Caruso… Armstrong was a "natural" in the studio. Their performances didn't have to be adjusted or adapted to technology" (2003, pg. 31). Because their musical style suited the phonograph they could be recorded at a higher quality than others. In most cases these artists would become more popular than others who couldn't be recorded as well and thus could be discovered much easier like in the example above. Other artists, however, were often left out and had a much smaller chance of being discovered. This

effect lowered the variety of music that could be released on record and thus limited musical discovery.

The limitations of recording with a phonograph would not stop there. If the music that was being recorded was too loud or resonated with the needle of the phonograph it would cause the needle to vibrate more than intended and distort the sound. For this reason drums were very difficult to record. As Katz points out, “Drums also fared poorly… you couldn’t use a bass drum, which vibrated too much, or a snare drum, which came out blurred” (2010, pg. 91). As a result many people replaced drumming with sounds that agreed better with the phonograph such as cow bells, washboards, wood blocks, and the sides of drums. Using the same argument from above, these aspects weren’t as prevalent in early music and therefore were not as easily discovered.

Recording with the early phonograph involved playing directly into the horn so that the sound would be directed toward the needle and the needle would vibrate, thus recording the sound. Consequently, it was necessary to be close to the phonograph when recording. This limited the recording ability of large bands because they had too many members that would have to crowd around the phonographs horn. A Victor recording engineer in the 1900s recounted this sometimes humorous event: “The violinists… would oft times run their bows up the bell of the clarinets which were being played directly above them or in one of the other musician’s eyes” (Katz 2010, pg. 43). Some groups were so large that they were compressed when it came time to record or they would bypass the recording process altogether. Because

these larger groups weren't recording or they would change their music this hindered their discovery.

Another limitation the phonograph had was its limited recording times. At first records could only hold a song or two. The 45 and 78 RPM formats that were standard could only record 4 minutes per side. This again limited the artists that were able to record effectively. For example if a composer wanted to record one of his hour long performances than multiple discs were required with multiple lengthy breaks for flipping and exchanging records. This obviously had a negative effect on the listening experience and would scare away consumers from buying these records. This led to songs being cut in length to fit on a single record. For example, Mischa Elman cut nearly a quarter of his take of Chopin's Nocturne in E-flat (Coleman 2003). This limitation also caused many artists to create only shorter songs so they would fit on the disc. Igor Stravinsky, a composer, tailored the lengths of his movements in his Serenade for Piano to match up with the amount of time you could fit on a side of a 78-rpm disc (Coleman 2003). As such some genres like classical music for example were not as popular. This slowed the discovery of these forms of music. Later the long playing disc or LP was invented. This disc could hold approximately 45 minutes in total allowing a wider range of music to be recorded, distributed, and discovered.

The phonograph introduced the world to recorded music. With this came an extraordinary increase in the ability to discover new music. However the phonograph had many limitations which we can observe in retrospect as clear faults in terms of musical discovery.

Another device which eventually worked side by side with the phonograph and other devices was the radio.

Radio

The first commercial radio broadcast took place in 1920. It didn't take long for radio stations to arise nor for them to start playing music in the form of records on air. Since radio only cost the price of the receiver the music the audience would receive was essentially free of charge. Record companies noticed this and quickly music was banned from radio stations. Although many radio stations secretly played music this delayed the onslaught of music discovery that was to come.

The radio and the phonograph provided the same purpose, to dispense a musical experience. The only differences were that the phonograph required you to make the music selection, whereas the radio played the music a DJ would select for you, and that the phonograph required records which came with a price tag and the radio did not require any peripherals. Since the phonograph required the user to buy the records before you played them users would have to discover their music prior to the purchase. On the radio the music you hear could be completely new, but at the same time it could be music you don't necessarily like. The radio is a good example of all four types of music discovery, passive, active, effective, and noneffective. For example, you could be listening to the radio as background music as you cook dinner. The radio isn't on for music discovery purposes therefore if you, by chance, discover a new song it would be passive discovery. This song could be akin to your tastes or it could be something you don't care for, therefore it could be both effective and noneffective. If you wanted to listen to the radio for the purpose of discovering music you could change the dial to

a new station and you would be hearing music you've likely not heard before. It would even be considered active discovery if it wasn't a new station as long as you were listening for the purpose of discovery.

Once the transmission of music via radio waves was finally accepted it would place the final piece to the music discovery puzzle. The relationship of the radio to the phonograph could at first be viewed as a competition. Because music on the radio was free it was halting record sales. This came to a climax with the Great Depression. Coleman depicts this decline in Playback: "The manufacture of record players had all but ceased by 1930. Disc sales had dropped by half. Record sales hit 110 million in 1922; ten years later, the figure had fallen to six million… By 1932, the U.S. music industry touched rock bottom" (2003, pg. 38). Although the radio suffered as well it wasn't hit nearly as bad because radio stations were secretly playing records and thus taking some of the market from the record companies. The radio however helped the record business climb out of the Great Depression and at the same time set a very important precedent. As people listened to the radio they would discover new music. If they enjoyed this music they would then be more willing to buy the record because they already knew they liked it. The radio served as a sample before the purchase. This "discovery to purchase" trend stuck and still takes place every day today.

In the 1930s the radio was placed in a car. This simple concept gained steam and with the booming automobile business was made standard in most automobiles. This was the first instance of a "mobile" (although limited) device. Although the music is constrained within the car, it still travels and is therefore considered mobile. The entire car could be considered a

music listening device as some people in modern times bring their cars to locations like a park or a basketball court and turn the volume on their radio up to listen to it while they are playing. The innovation of having a radio inside every car which, most families owned, brought essentially free music to an even wider audience. Those that held out and didn't buy a home radio now had one in their car. As such, the more people listening to music, the more there is opportunity for music discovery.

Another important aspect of the car radio was the continuation and solidification of a precedent set by the home radio that aided passive discovery. The concept that made the car radio so successful is that driving can be a rather monotonous activity. The driver can't be physically doing anything because they have to pay attention to the road, but they can listen. The car radio provided the driver with entertainment during a mundane activity. The same can be said for the example I used previously of the person listening to music while cooking. People during this time started listening to music for background noise and entertainment during boring every day activities. This not only increased the amount of music being played but also increased the amount of music discovered passively.

The final radio device we will mention is the transistor radio. In the 1950s the transistor was invented and allowed for devices with more mobility. Transistors allowed radios to become smaller because they replaced bulky vacuum tubes and allowed them to operate with less power. The transistor radio made use of this technology and became the first true mobile listening device. The transistor radio could fit in your pocket and you could listen to it anywhere there was access to radio waves. Since people were listening to music outside and in public

places, more people had access to music therefore aiding musical discovery. As Coleman says "The top 40 revolution was sparked by transistors," bringing music ever further into the mainstream audience (2003, pg. 86).

Tape

The future of music listening lied in the hands of portability. The transistor radio proved that people wanted their music with them everywhere. This goal was ultimately met with the advent of tape players. The first popular tape player was the eight-track which was invented in 1964. Although it wasn't the best tape player it gained popularity because it was added to cars in addition to the radio. It brought with it the ability to choose your music on the go, as long as on the go means in your car. The cassette tape would soon dethrone the eight-track due to its durability, and higher technological capabilities such as rewinding.

The boom box, which at first incorporated eight track players and later cassette players, would bring mobile listening to a new level. The boom box, which arose in the 1970s, was a combination radio, tape player, and speaker system. The boom box became synonymous with one word, loud. It was perfect for the teenage demographic which stereotypically loves to rebel, annoy people, and listen to music. Young adults would roam the streets with these loud "ghetto-blasters" which played their music to anybody within moderate proximity. Older adults, who probably weren't akin to the music the young adults listen to, would be annoyed and therefore wouldn't enjoy the music they heard (Kelley 2009). This makes it a great example of passive, non effective music discovery.

The quieter alternative to the boom box came in the 1980s in the form of the Walkman. The Walkman was a portable device that played cassette tapes. Cassette tapes would replace

eight-tracks in automobiles as well as in general. With the portability of a Walkman, the eight track stood no chance. Now the user could play all the music they owned anywhere they wanted and they wouldn't be annoying anybody because the Walkman played its music through headphones. This had many social effects including the effect it had on music discovery. With tape players and tape recorders music was now much easier to record, copy, and distribute. The cassette tape was physically smaller than any peripherals before it and was much easier to pass out to people on the streets. These technological advancements led to the growth of underground scenes in both hip hop, punk rock, and jam bands. Tapes could be recorded at live shows or in someone's basement and they could easily be replicated and distributed thereafter due to their small size. It became much easier to discover these small underground groups. This same effect was observed in North India. As Katz describes in Capturing Sound

> Before 1978, cassettes were rare in India (LPs being dominant), and a single entity, the Gramophone company of India (GCI), controlled the nation's recorded music. GCI's monopoly led to an extreme concentration of performers and styles…The arrival of the cassette utterly changed the pop scene. The complex, cheaper medium allowed smaller labels and even individuals to create and distribute recordings, ending GCI's stranglehold on the mark. This diversification brought new perspectives, giving rise to new stars, even new musical genres (2010, pg. 15).

The ease at which cassettes could be created, destroyed the grip GCI held on the Indian music scene allowing a more diverse group of musicians to be discovered.

In some cases this underground music scene grew to extreme levels. One particular instance of this can be observed in the use of tape recording to record live Grateful Dead shows. A jam band like the Grateful Dead make studio albums just like every other band but their live performances are what most fans love to hear. In their live performances they will stretch a song that was originally five minutes into a ten or twenty minute jam session. This gives the recordings of their live performances a high demand. The Dead would record their live performances onto tape and distribute them amongst their fans. The cult like following of the Dead called "Deadheads" could then easily replicate these tapes with the new technology and further distribute this content to every Deadhead that wanted it (Paumgarten 2012).

Compact Discs

When technology reached the digital age, the compact disc (CD) served as the listening medium for digital music. The CD held many similar qualities as the cassette tape but improved upon all of them. The CD was even more portable. There was also a portable CD player similar to the Walkman but CDs could be stored more efficiently because they were much thinner. A major difference from cassettes was that CD's were far more durable. Tapes would degrade each time they were played and the tape could easily become disheveled. The only problem for CD's were if they got scratched. The CD also improved on the ease at which you could copy and distribute music. Music from CD's could be ripped onto computers and then burned onto another disc with mere mouse clicks. Furthermore with the advent of the internet and music sharing programs, music could be shared from one computer to another. This created a similar problem as the radio did; free music. Although this sparked much debate and a huge legal debacle the ability to share music to and from anywhere in the world opened the floodgates, so

to speak, for music discovery. Now you could discover music for free very easily. This led to many active, effective discoveries; people searching the web for music they enjoyed. Due to the CD's increased portability music could also be distributed easier and at a much higher rate. This again was great for the discovery of underground scenes.

Modern Software/devices

Today, with the invention of the internet the concept of music discovery has been accelerated to its highest level yet. Now any music you want is available as long as someone has put it on the internet. With the advent of high capacity hard drives, flash storage, and more recently cloud streaming, it is now commonplace for a user to be able to carry his or her entire music library on his or her device. Furthermore, streaming services such as Spotify have done away with the concept of owning a library and have shifted towards enormous libraries with millions of songs. This rapid evolution has had both positive and negative effects on societal interactions.

The first popular online music service was a file sharing program called Napster. It was created by a college student, Shawn Fanning, in 1999. It allowed users to share their existing music with others through the internet for no cost. As this service grew in popularity, especially in the college student demographic, the amount of music being shared was almost infinite. Not only could you access the studio album versions of almost every song but you could download multiple live versions and even demos before the actual song was released. This service ran into legal troubles when multiple record companies placed lawsuits for copyright infringement. Essentially consumers were getting free music and record companies and artists were not getting any royalties. This is similar to the effect the radio had at it's inception but on a much

larger scale. At it's peak Napster had upwards of 80 million users. By July of 2001 however, due to legal issues, Napster was shut down and filed for bankruptcy. Although this service was eventually terminated it set many new precedents for the way modern music was going to be consumed. It proved that there didn't have to be a physical medium anymore for music but rather it could be transferred via the internet. It also paved the way for many copy cat softwares like morpheus and limewire that essentially did the same thing as Napster and would eventually reach the same fate. Finally it settled the issue of file sharing on the internet and proved that their had to be some form of payment for a legal service to exist. These results can be seen in programs that are used today like Spotify, iTunes, and Last.fm.

Whether actively searching for a new song in a store-like setting such as iTunes, or passively discovering songs through the use of Pandora or Spotify Radio, technology has allowed new ways to discover new music while also asking new questions. One such question is how to recommend a song to a user based on past listening history. Many services such as the previously mentioned Pandora and Spotify Radio have attempted to answer the question, but there undoubtedly remains room for improvement. Part of the problem stems from most listeners' allegiance to a specific genre. Most music is only part of a genre's bigger culture. One example of this is hip-hop, where distinct clothing and consumption rituals are part of the culture. (Ebare, 2004) This identity to a certain culture makes it hard to break through and recommend music outside of the listener's culture. "Adolescents typically identify their peer groups according to their preferred clothing styles, music, activities" (Sussman, Unger, & Dent, 2004). Adolescents especially tend to be loyal to a particular music culture. With this in mind it

would seem that although music discovery is much easier at this point in time, it remains difficult to introduce new genres to listeners.

Radio features that are carried in programs like Spotify, Pandora, and iHeart radio, have had a similar effect as the original radio. The only difference is that with the power of the internet and software there is no DJ allowing you to shape your own musical experience. Based off musical trends these radios will play songs similar to an artist, album, song, or even situation, introducing the user to new music. Similar to the combination of radio discovery and record purchase, users that hear music they like on these services often purchase the song or album digitally. Modern technology used similar concepts that have already been observed and created the same effect on a much larger scale.

Another topic of particular interest to this project is the music discovery algorithms music discovery services use. The most documented version of these algorithms is the music genome project which is used in Pandoras radio software. This was a large scale attempt to mathematically break down every song into its “genome,” a description of the song with somewhere between 150 and 500 “genes.” These genes or attributes range from many different aspects from “gender of lead vocalist, to time signature, to amount of distortion on electric guitar” (Morell 2013). Combined these genes form a music vector. When you play a pandora station from a particular song or artist it attempts to match that song with songs that have a similar music vector. Furthermore it allows you to rate the selection it’s made by either choosing a thumbs up or thumbs down rating for each song. This is then factored into the next selections further refining the music vector it’s searching for. Although many services use

algorithms similar to this and in some cases are very successful, it remains difficult to perfect an algorithm for music discovery. As Morell argues “What’s missing from the vectors are the indefinable qualities of a great song, such as the unexpected brilliance of a key change or the cadence of the singer’s voice” (2013). There are certain qualities of a song that make it great that aren’t necessarily quantifiable and therefore can’t be put into an algorithm. Morell goes on to explain an experiment he carried out where he listened to a new band everyday. He found that he normally listens to bands that have collaborated with bands that he has previously listened to or bands that have opened during live performances for other bands he enjoys. He argues that “The headlining bands who invite openers to go on tour with them are providing a similar service to Pandora but on a more personal level, in effect saying, I like this band and trust them enough to set the tone for the night, so maybe you’ll like them, too” (2013). This is an interesting concept that is true in many cases.

Another service that offers music streaming and a discovery service, Spotify, combines all of these effects. They have a special page titled discovery where you can go to discover new music. They have recommendations based on an algorithm for similar artists based on songs, single bands, multiple bands, and albums that you have previously listened to. They also notify you of local shows of bands that you normally listen to providing you with the chance to discover new music at that show. Although these technologies may never be perfect due to the indefinable qualities of music they are still a giant leap forward in music discovery that was available in the early 1900s. Besides this discovery feature you can listen to music that you select or even use their radio feature which is similar to Pandora. Furthermore, Spotify has created a social atmosphere which acts like a social network for music discovery. It works in

conjunction with Facebook creating a Spotify account linked to your Facebook profile. If the user wishes they can display the music they listened to automatically on their facebook page, exposing the music they listen to to all their friends and people that visit their profile. In the Spotify application you can choose to follow your friends, other people, bands, and playlists. The songs these other people listen to will appear on the side of the application on a ticker in a similar style to Facebook. Bands or songs that are frequently listened to by your followed users will also appear on the discover feature that Spotify offers. With all these discovery options Spotify seems to be at the forefront of music discovery software. Our research will look to prove this statement.

Ever growing music technologies have created an exponential curve for music discovery. At the beginning the phonograph made music a physical device which allowed for the sharing of music. Although it had its limitations it was the start of the music technology timeline. With the advent of the radio, music became more and more common. Working alongside the record player, the radio introduced new music to the consumer which led to the popularity of this music which led to the purchase of the records. The next outbreak of music technology happened when music was made truly portable. Cassette players and CD players dominated the market for thirty plus years. The ease at which cassettes and CDs could be created led to widespread recording and the emergence of underground scenes. An even broader range of music was now easily at the hands of the consumer. In modern times the internet and multiple music listening programs bring an infinite amount of music at the disposal of the consumer. This service was at first in the form of illegal downloads but was eventually evolved into paid streaming services that gave the user a cheap way to have the same music library in a legal

manner. As these software developed, they focused on music discovery making it easier and easier to discover new music.

3 Methodology

The Objectives of Our Paper

While previous devices and services such as the record player and phonograph have existed for decades allowing researchers more time to study, the current crop of devices and services such as iPods and Pandora are relatively new. The goal of our study is to develop quantitative analyses that can determine the effectiveness of using these new devices and services to discover music. As we determine which services, features, and devices are most effective we can use traits from them to recommend an optimal music discovery service that will hopefully meet everyone's needs. The following methodology outlines our procedure.

Small-scale Data Acquisition

First, we wanted to look at individual user habits on a small and detailed scale using a journal study. This type of study required that every participant keep a journal with them at all times in the event that data must be recorded. We based our study off of the following studies.

Nettamo, Nirhamo, and Hakilla (2010) used human subjects to gain proper insight. The goal of the study was to explore "the personal relationship people have with music entertainment technology and content, and explore how music is enjoyed on the move." They aimed to compare and contrast the findings across two different cultures. They used the following methodology to accomplish their task.

Nettamo, Nirhamo, and Hakilla first recruited twelve participants, six from Hong Kong, and six from New York to take place in their study. At each location, three of the participants

were males and three of the participants were females to create an even gender distribution. The ages of these participants ranged from 20 to 33. Every participant had to have an mp3 player and a digital camera. Over the course of 3 days they were supposed to make a journal entry on every occasion that they used the mp3 player. Each time the participant made a journal entry they were also required to take a picture with their digital camera to include in the journal with an annotation. The annotations explained what the picture was taken of, where it was taken, and what the participant was doing when they took the picture. There was no limit on the amount of entries to be made by the participants. Afterwards, each participant was questioned for two hours about their journal entries.

Some of the problems with the methodology were the large varying ranges in pictures and entries. One participant took 6 photos, while another took 80. Another problem was the inability of some participants to take relevant and clear photos (Nettamo, Nirhamo, and Hakilla, 2010, p. 89). Due to these problems we did not include the photo portion of this study in our study. We did however, have participants create journal entries in every instance in which they listen to music, similar to this study. Due to the nature of our study we could not include the interview process outlined in this study because our study took part at the end of a term of classes and students were not available to interview. We also decided to have a clear template for what the participants should write about, rather than leaving it open ended. This template can be viewed in Appendix B.

Bainbridge, Jo Cunningham, and Mckay (2007) had a study with a very similar goal to our study. The study looked at “how we, as individuals, purposefully or serendipitously encounter new music.”

The methodology of this study hinged on the use of journals. A total of 41 participants were selected from a third year class on Human-Computer Interaction. Over the course of 3 days the participants were tasked with writing down every incident in which they discovered new music. They did this in a journal, which consisted of a paper template. This template asked for the time and date, their physical location, a description of the activity or circumstance that led to them hearing the music, and any comments that they had about the incident. Over the course of these 3 days, 409 total songs were found amongst the 41 participants, just slightly less than 10 songs discovered per person over the course of the 3 days, or roughly 3.3 songs discovered by the average user every day. At the end of the study each participant was tasked with writing a one to two page report summarizing these journal entries. This report was supposed to help the researchers better understand the journal entries.

In this instance the incentive for the study was that the participants had a portion of their grade attributed to their participation in the study. While this was a very effective method that led to a full set of responses over the course of the study, it is unfortunately an option which we didn’t have. For this reason we used gift cards as an incentive instead. We planned to give away five gift cards out of twenty participants but since we only received eight journals back at the end of the study we only gave out two to keep the ratio, and therefore the odds of winning, the same. Another aspect our study had that was similar to this study was the

requirement to include at summary at the study's conclusion. We decided the summary should only be a paragraph because we didn't want to scare away potential participants with a one to two page report.

In another study Sun, Sharples, and Makri (2011) aimed to examine the instances and benefits of serendipity in everyday research by recording instances of serendipity and emotions evoked in those instances. They decided to have the participants record these instances in a journal. The main reason for using a journal study was because they "differ from other social science methods by reducing the time between an event's occurrence and recording the information; hence, it is less subject to memory lapses." This is an important aspect of journal studies, and one of the main motivations behind our use of journal studies.

In this study, 11 PhD students involved in at least 1 year of individual research were chosen. The study took place over the course of one week and the users were required to keep the journals on Android phones. The diary entries in this study were described as being "qualitative" and as such did not allow for numerical analysis techniques. The researchers felt this took away from the study and is part of the motivation behind our decision to use a template to acquire quantitative results such as number of songs discovered. Although the use of Android phones in this study was useful and convenient we decided to use small 4" by 5" paper journals so everyone could participate in the study, not just smart phone users.

For our study, we tried to get between 20 and 24 participants. We chose this range of participants because from the 3 studies we looked at, the average number of participants was slightly under 22 and we wanted to give ourselves a cushion in the event that we had slightly

too many, or too few qualified participants. One of the most important parts in selecting the participants is providing a worthy incentive to participate. As we stated above, we planned to give a $25 iTunes gift card to five random participants but since we only received eight journals we only gave out two to keep the odds of winning the same. These participants were chosen through the use of a random number generator, in an effort to make selection completely objective and unbiased. All participants were assigned a number from one to eight and then we generated two numbers between one and eight to determine winners. We advertised the study through email, word of mouth, and in music classes. We asked music professors if we could present our study at their end of their classes in hope that the students would be interested. This was the most effective method giving us the majority of our participants.

Over the course of the 3 week study, participants were instructed to go about their everyday life as normal, listening to music how they usually do whether that's using Spotify on their smart phones or using a record player. Whenever a participant experienced discovery he or she documented it in a journal following a template which can be viewed in Appendix B. The questions that were asked were split into two sections. The first section required the participant to answer a set of ten questions every time they discovered new music. These questions were short and simple requiring a one or two word answer. The final question of this section was open ended, allowing the participant to include anything they felt was relevant. In some instance these questions may not be able to be answered fully, such as if a participant hears about a song from a friend. In that instance, there is no device being used, nor is there a service being used. The participant would then leave those portions blank and explain in the

comments. At the end of every day the participant answered the question in the second section that details how much music they listened to over the day using which devices and services.

At the study's conclusion the participants wrote a reflection summarizing how they felt the study went. This included everything from suggestions of improvement to feelings about how the study changed the way they view their day to day music experience.

In order to make sure that the participants were doing the journals in the proper manner we emailed them after one week and asked them to send us an example entry from the journal. If there were any issues with the responses we pointed out the mistakes so that they could continue the study properly.

One of the main problems with this study is that the sample size is relatively small, meaning that we may not end up with the most heterogeneous sample. This is why we intend to supplement this research with a survey that will have more respondents.

Surveys

The second part of our research methods is a survey. The purpose of the survey was to gather large amounts of data about the entire population. The surveys were not as personal as the journal study, but it allowed us to make more general claims about the population. We based our survey approach off of the following studies.

Prior Surveys

Komulainen, Karukka, and Hakkila (2010) used a survey in a study conducted in Finland. The goal of this study was to "look at the omnipresence of music and the social perspective of online music services among the youth."

The survey was conducted in person at a musical gathering of young students in Finland. In order to obtain a reasonable demographic for the survey, the group conducted a brief interview. This interview focused on the music service usage, and music sharing of the participant. Once the participants were deemed appropriate they filled out a 13 question questionnaire anonymously. The questionnaire "covered versatile aspects on frequency and ways of listening, sharing and discovering music, as well as the social use of music services." Some examples of the data gathered from the questionnaire are what devices participants listened to, whether the participants listened to individual songs or albums, what music services the participants used and what devices these services were used on, and how the participants shared music with others.

The study did mention that the survey was conducted with a very homogenous sample, meaning that the results were not indicative of the general population, but rather the average 16-17 year old. In order to gain a more diverse sample, we attempted to administer the survey to different demographics. The researchers also commented on the relatively small population of 12 participants. We tried to have as many participants as possible and tried to spread the survey to as many groups of people as possible. The questions that were asked in this survey were also very useful when we were creating our own questions. As you can see from our survey which can be viewed in appendix C, many of the questions were similar.

Kamalzadeh, Baur, and Moller (2012) also used surveys as part of their methodology in their study. The primary goal of this study was to look at music listening and management behaviors. This study administered a 32 question online survey to 222 participants, with 13 of these questions covering collection management, 14 covering music listening, and the remaining 5 covering the demographic of the listener. Participants for this survey were mainly acquired through mailing lists that were sent to Simon Fraser University's (Canada) Computer Science and Engineering faculty and students. After these student and faculty received their invitation they were encouraged to spread word of the survey through what is referred to in the study as "snowball sampling." The study however did not specify exactly how many of the 222 participants were a result of this "snowball sampling."

The only problem apparent with this study is once again the homogenous sample. The average age was just under 26 with a standard deviation of 9.02. The age was not as homogenous as the previous survey done by Komulainen, Karukka, and Hakkila, but in this study, 95% of the participants had a Computer Science or Engineering background, and 73% were males. This ultimately means that these results might not necessarily be representative of the general population, rather a specific demographic. This was more inspiration to try to reach a wide demographic. We tried to use "snowball sampling" in our study as well based off this study, but due to the software we used the only "snowball sampling" was from other people spreading our survey.

The final study we will look at was conducted by Tepper, and Hargittai (2009) titled "Pathways to music exploration in a digital age." This study's aim was to find "how young

people find music that was new to them in an environment with an unprecedented number of possibilities." These possibilities were identified later in the study as physical stores such as Wal-Mart, online retailers such as Amazon, and digital storefronts such as iTunes and Rhapsody. The data used to help answer this question was acquired in a survey taken over multiple years, from 2003 to 2005. This survey was designed to look at "how college students learn about new cultural products", with a subset of the survey being focused specifically on musical interests. In total there were 22 questions in this subset solely about music consumption and discovery. Most questions involved sources of discovery, from personal acquaintances to online services such as iTunes. Regarding participants, this study consisted of 328 college students. The distribution between freshman, sophomore, junior and senior levels was 23%, 33%, 23% and 22% respectively, and the survey participants were selected from students enrolled in sociology courses at 3 different colleges. These colleges were located in the Northeastern, Midwestern, and Southern regions of the country, with intent being to obtain a more heterogeneous sample.

While this survey approach was very effective, certain aspects could not be replicated in our study for various reasons. First, our survey could not take place over multiple years because we have a time requirement for our IQP. Due to time constraints, and having to wait for approval from the IRB, our survey took place over 6 weeks. We were able to keep the survey open over our winter break giving us a decent time interval for our survey. Another aspect that we couldn't replicate for this study was the ability to obtain results from all over the country. We did not have the connections, resources, or time to obtain a wider audience so our participants were mostly from the New England area. Although we weren't able to take these aspects of the survey we were able to get a better understanding of the format and type of

questions we should be asking on our survey. For example, this survey had 22 questions which we kept in mind when we were creating our survey which ended up being 16 questions. This number was also based off the amount of time it took to complete our survey but it was also based partly off of this study.

For our survey we combined the positive aspects of these three studies and tried to avoid as many negative aspects as possible. We gave out a questionnaire of 16 questions. The first 3 questions asked about the demographic of the participant, while the remaining questions asked about the general aspects of the participants' everyday musical consumption and discovery experience. These questions ranged from simple questions like "How many hours of music do you listen to in a typical week?" to "How often do you use the following devices to listen to music?" These types of questions were primarily slider questions. This type of question allows the user to drag a slider from a minimum value to a maximum value and anywhere in between. For the types of questions that asked we thought it would be useful to have an average value of how much each device was used or used for discovery for example rather than a multiple choice of which device was preferred or a ranking of devices. This allowed us to do a more in depth analysis where we could compare the average values of each answer for ourselves and even compare them to other questions. The full survey can be viewed in Appendix C.

General Survey Methodology

Another aspect of our survey that we needed to put some thought into were general survey methodology techniques that are smart to abide by in any survey. These techniques cover organization, length, distribution, and question structure.

One of the major recurring themes that popped up in our research was to make sure our questions had purpose. In many surveys there are empty questions that are sometimes hard to answer and don't provide useful information for the purpose of the study. To avoid doing this we clearly defined our purpose for the study in the email that we sent out notifying people about our survey. With a clearly defined purpose we could look at each question in our survey individually and decide whether or not they provided information that was useful for our study. For instance, one question we originally had was "Music I discover is typically in…" and it was multiple choice where one answer was "One of my three favorite genres" and the other answer was "A different genre." After inspecting this question again we decided that for the purpose of our studies this would give us a very general yes or no answer that wouldn't help us discover the information we truly wanted to know. To get better data from this question we made it more specific to each genre. The question now read "How often do you discover new music in the following genres (including music that you don't like)" and listed all the genres we are studying next to a slider that allows the user to rank how often they discover music in each genre on a scale from "least" to "most." Since we changed it we received information from each genre allowing us to compare this question with a previous question asking the user which genres they enjoy allowing us to see if the user discovers more music in genres they like or in genres they dislike which was the intended purpose of the original question.

There are many aspects of surveys that may seem obvious but are actually very important in the final results you obtain. One of these was the length of the survey. Often people are reluctant to take surveys longer than 10 minutes. We wanted our survey to only take five minutes so we could advertise it accordingly and more people would hopefully

respond. Another technique was to make the survey as simple as possible. This was done by keeping the questions basic and short using standard vocabulary that would be understood by our audience. Next, was to stay consistent with the use of scales throughout the survey. Especially for our survey where we use a lot of slider questions this was important. For our scale we chose to make the left side of the slider to be never, least, or ineffective and the right side of the slider to be always, most, and effective. It is important to keep these consistent to limit confusion and provide accurate results.

A very important aspect of a survey is its organization. If the survey isn't organized it can lead to confusion which will lead to undesirable results. Our survey was organized into three basic categories. The first category asked general information questions about the participant such as age and education level. Then, in the second category, our questions targeted the general music listening habits of the user. Finally, in the last category, our questions got more specific and asked about the music discovery trends the user experienced.

To ensure our survey met the criteria we explained above we tested our survey on about ten people to see if we followed the things discussed in this methodology (simplicity, organization, consistency, length) and changed parts of the survey that were deemed unfit.

The final aspects of general survey methodology we researched were optimal distribution techniques. Our survey was made online using a tool called Qualtrics. Since our survey is online it is technically available to anybody with an internet connection. To notify as many people as possible we sent an email to every group email we could at WPI. Due to student government rules we couldn't just send an email to all students so we had to find

individual groups of students to email. We ended up sending the email to humanities and arts majors and minors, all employees, biomedical engineering majors, electrical and computer engineering majors, chemical engineering majors, the Alden Voices club, the Glee Club, all graduate students, and three fraternities/sororities. It's optimal to make sure this email is sent out on a weekday around noon to ensure a high response rate, however it was difficult for us to find authorized people to send out our survey to groups of people so our survey was sent our at their discretion. We also used social media web sites such as Facebook and Twitter to distribute our survey. We shared the survey on our personal Facebook and Twitter pages as well as shared it on the WPI alumni Facebook page.

The other methods we used involved meeting with people in person and asking them to take our survey. People are more willing to accept an offer take a survey in person as opposed to an email and this also allowed us to reach out to more people. Our first attempt was made in table sitting at the WPI Campus Center. We brought two laptops and asked people that were walking by if they would take our survey. We did this for two hours obtaining approximately thirty responses. The other attempt was made at a choir rehearsal. We were invited by the instructor to present our survey to approximately two hundred people at a rehearsal on campus. When we arrived we obtained the email alias for the group that was meeting which allowed us to send the survey out to them allowing for easy access to the survey. This method was slightly more effective resulting in approximately sixty responses.

Determining a Sample Size

With regards to selecting a sample size, our goal was to have at least 384 participants in our survey. The 3 determining factors when selecting a sample size are level of precision (margin of error), confidence level, and population size.

The level of precision, or margin of error, controls how much error is allowed in the survey for each question. That is, if 78% of the respondents say yes to Question A, if the confidence interval is 5%, we can be positive that between 73% and 83% of our population would say yes to Question A. For our survey we chose to use a level of precision of 5% because it is relatively compact, giving us a 10% range that we know the entire population will fall within for each question, while also allowing for a manageable sample size.

The confidence level is a number representing how confident a researcher can be that the results obtained from a survey are representative of the population's answer to that question. With a 95% confidence level, that means there is a 95% chance that our sample is representative of our population. This value of 95% is very common as it allows for statistically relevant studies while also keeping the sample size manageable (Israel, 2009).

The final piece of criteria when determining a sample size is the size of population that is being sampled. In our case, we chose the population size to be that of the United States, roughly 314 million. While this number may seem excessive, due to the nature of calculating sample size, populations larger than 250,000 yield the same required sample size at the given level of precision and confidence level.

Problems

One problem with this survey is that it has relatively homogeneous sample. College students and peers made up an overwhelming amount of our sample. This was the main inspiration behind the demographic section of the survey. With this section we were able to understand who took our survey and therefore who we could make conclusions about. For this reason, the conclusions that can be drawn from our survey apply primarily to college students. In our analysis we will often make the assumption that college students listen to the most amount of music so that we can make general claims.

Another problem is the fact that people don't always represent themselves accurately on surveys. That is they might indicate that they listen to eight hours of music every day, when in reality they listen to 10. In order to see if our survey was representative of what the participants actually did, we compared the results from the survey to the results of the journal study to see if they were consistent. Since the journal study required participants to write their responses daily regarding how much music they listen to and record every instance of discovery we hoped to receive more accurate results. This turned out to be untrue because we had the same problem with the journal study. People didn't record responses as often as we would have liked and therefore this comparison probably isn't accurate.

Even though there are some problems with surveys we still received favorable results because we identified the problems and kept them in mind when we were analyzing the data.

Data Analysis Methods

We analyzed both sets of our data in the three following ways: frequency plots, histograms, and the variable axes technique.

Almost every question from the journal and survey studies allowed us to create a frequency plot. These plots can take the form of bar graphs or pie charts. They show a very basic analysis of how much of something was done. For example in Figure 15 you can see a frequency plot for the total devices used in a journal study. You can quickly see which device was used most often and which devices weren't. These plots were very useful in comparing our results. We were able to determine the most popular services, devices, genres, and activities as well as the frequency of discovery for each of these topics. They were also useful in comparing discovery data and listening data. When super imposing the graphs, like in Figure 7 for example, you can tell how effective a device or activity is at discovering music.

The next tool we used for analyzing data was histograms. These graphs are scatter plots that have a point for every instance something happened at a specific value. The more something happens at that value the wider the distribution at that point gets. You can see an example of this in Figure 4. Each time an active discovery was made at a certain rating another point was added on the chart. The more data points at each rating resulted in a wider distribution. Once you have plotted each data point you can view the complete distribution which tells you the most and least common ratings. This was helpful for our analysis in the journal study that involved a user's willingness to listen to a song again. We were able to determine whether active or passive discovery was more effective and whether or not discoveries that involved people depended on the effectiveness of the discovery.

The final method of data analysis that we used were variable axes. These variable axes compare and contrast certain characteristics of specific participants. Figure 1 shows an example

of variable axes from the Nokia study. The figure shows how the variable axes helped find similarities between certain behaviors of users, in this case the use of a file manager and where the user initiates playback from. Conversely, these axes could also be used to demonstrate that there is no correlation between certain behaviors. If the numbers in either one of the axes were randomized we could come to the conclusion that there was no correlation between the two behaviors. This technique was crucial in our journal study because it allowed us to compare individual participants listening habits.

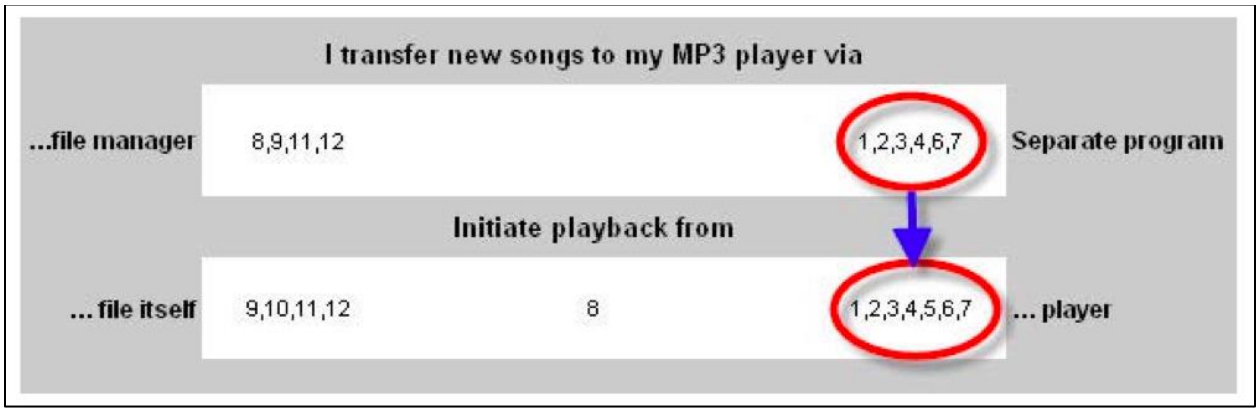


Figure 1 An example of data analysis with variable axes.

Conclusion

Throughout history technology has changed the way we discover music. From the invention of the phonograph allowing people to be able to listen to musical recordings, to the radio providing a very common means for passive discovery, technological advancements have been important factors in a change to our listening habits. While the impacts these older devices have had on society are well understood, there still remains research to be done on the newer devices and services. With the following methodology, we believe we have achieved our goal of finding and looking at the effects that these new devices and services have had on music

discovery. Furthermore we believe we can use this research to recommend an optimal modern music listening and discovery service. The two pieces of our methodology each served a crucial purpose in understanding these effects. The journal study allowed us to look very closely at the everyday impact these technological advancements have had on a small group of people, while the surveys allowed us to look at a much larger group of people so that we could draw conclusions about a more general population.

4 Results, Discussion, and Analysis

Journal Study

Introduction

Initially we handed out twenty journals to WPI students. There were four groups of participants that were formed based on the date we handed the journals out. After the three week research period for each designated group, we managed to collect back eight of our journals. Of the eight participants, six were male and two were female. We did not record their names as this study was done anonymously, so if we refer to an individual participant they will be referred to as participant 1-8. For analysis purposes we entered the journals manually into an Excel spreadsheet file. For each entry in each journal we recorded the answer to each question from both sections of the journal. Additionally we added a row specifying which journal participant was related to each entry. An example of this data entry can be viewed in Figure 14 in the appendix.

To condense the data certain entries were relabeled to fit into a broader category. For example one genre was changed from “Trap” to “Hip hop/Rap” and another was changed from “alternative rock” to “Rock.” Other similar changes were made throughout the analysis in order to prevent certain outliers that could be accurately represented in another existing category. The following sections will now detail different analyses with the purpose of providing insight into how our participants discovered their music and providing us with useful information when proposing an optimal music discovery program.

Total Devices and Services Used

The graphs in Figure 15 and Figure 16 show part of the answers to section two of our journal study. In section two we asked our participants to list the devices and services they used each day and how many hours they spent listening to music. As you will be able to tell when looking at all of our data most participants didn't fill this section out regularly, so although the total data may be slightly off it should still give a decent estimate as to what the most used devices and services were. Looking at Figure 15 we have each instance someone reported they used a device. Instances of computer listening rose above and beyond all other forms of listening, having six times the amount of instances and almost six times the total time spent listening as the next device, the iPhone. We weren't surprised that the computer would lead in these categories but we didn't expect the large gap between it and its competitors. Coming in behind the computer was the iPhone. Strangely enough every participant that listed their phone as a listening device had an iPhone so for this portion of the study it's difficult to compare the two leading smart phone services in terms of music discovery. Coming in behind the iPhone are the radio and the iPod, tied at five instances. Wrapping up the graph, CD's, live music, the Nook, and mp3 player all recorded less than five instances. We can conclude that the computer was the most popular listening device of the study. One might then assume that most listening was done at a stationary location because computers aren't the most mobile of devices. Based on this data, when creating a new service it would be wise to first focus on a version that would be optimized for the computer. The next most popular device was the iPhone, so a mobile app for a smart phone would probably be the next best area to focus when creating a new music service. Because the iPod, CDs, MP3 players, and Nooks weren't used that

much there shouldn't be much focus on these devices or on similar devices like tape players, tablets, or kindles.

The total services used part of section two received even fewer responses from our participants. It's evident that it wasn't responded to on a regular basis especially considering that people listed other services in section one of the study and didn't mention them in section two. Nevertheless our results can be viewed in Figure 17. A staggering favorite was the Spotify program leading the next service by more than twenty instances. The other services which all recorded two or less instances each were Windows Media Player, YouTube, and ITunes. This data is consistent with the total devices used data as all of these services can be used on a computer and most of them can be used on a smart phone, the top two devices that were used. Since this question was not answered consistently, not much can be drawn from this data other than that Spotify is obviously a very popular music service.

Discovery on Devices and Services

Now that we've had some insight on the total services and devices used we want to move on to the heart of this study, the discovery results. First we'll look at the devices people discovered their music on. In

Figure 18 the results for every discovery in our study can be viewed. The computer category includes both desktop and laptop responses. The decision to combine these categories was made because many of the answers people gave weren't specific, for example some would write "PC" or in some instances "Computer" so we weren't able to distinguish between desktop and laptop. Regardless, the results you can see here are convincing. The computer leads all

other types of discovery by a wide margin. Almost every discovery made during this study was on some form of personal computer. The only other results were on the iPod, iPhone, radio, and Television but they were insignificant when compared to the discoveries made on the computer. This result can lead us to one of two conclusions when looking to make a new software: either we can focus on the computer because that's obviously where most of the discovery is happening currently or we could focus on another hardware like the smart phone because the current methods of discovering music on other devices, at least according to our results in this study, aren't effective and there's a need for greater software. Some of our further research that will be discussed later will help us distinguish between these two choices.

Another important result is what music services people are using. Since most people used the computer to discover their music, most of these services are some form of computer software. The results can be seen in Figure 19. The most popular devices for discovery were YouTube, Spotify, and Sound Cloud, each registering over 10 discoveries. The next highest was iTunes radio, raking in four discoveries and then a couple other services with only one discovery each.

To analyze this data correctly it's important to note how many users were making discoveries on each service. If we take a look at Figure 20 we can see which users discovered music with each device. As you can see the only services with multiple people were Spotify and YouTube, two of the services with over ten discoveries each. The other service with over ten discoveries, Sound Cloud, had only one user, participant 2. That means that this one user was responsible for all the discoveries with this service. From this we can conclude that since this

one user discovered more music using Sound Cloud than Sound Cloud is the more effective discovery service, or that this user was more active in the study and just recorded more responses. After looking over the journals and comparing the response numbers (13 discovery responses for user 2, compared to the average response of 6.625 discoveries per user) it was clear that this user was more active in the study and therefore skewed the results of this graph slightly. Taking all of this information into account we can conclude that the most effective (and popular) services for discovering music in this study were YouTube and Spotify.

Comparing the two graphs from Figure 17 and Figure 19 we can receive some more useful information. This graph can be viewed below in Figure 2. To make one note about this graph before we analyze it, we realized that a lot of people didn't respond to the second section of our journal study accurately especially when it came to the services used. A lot of people would leave this question blank when they were supposed to answer it daily and it somewhat effected the results, for instance in the graph you can see that there aren't many responses for the use

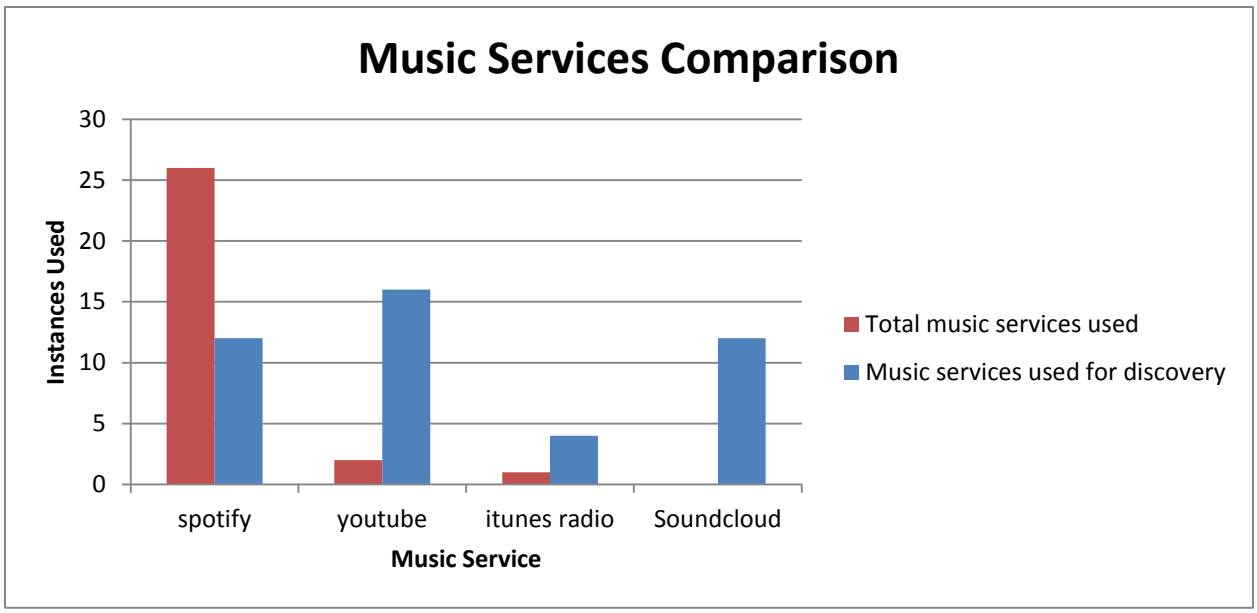


Figure 2 The comparison of the significant music services used and the music services used for discovery

of YouTube and there aren't any for Sound Cloud. Despite this inconsistency we can still draw one major conclusion from this graph. Although Spotify is a very popular music listening service and people do discover a decent amount of music on it, it appears that people discover more music via YouTube. There were more discoveries listed for YouTube than Spotify despite a huge deficit when it came to total instances used. Based on the data in this study we can conclude that YouTube was the most effective music discovery service. Another thing worth noting is that Pandora, a very popular music listening and discovery service was not mentioned at all in the journals. With a small sample size we knew that this would be a possibility because most people have one primary service they use that they stick to. Since this was the result we will only have our survey analysis to rely on when speaking about Pandora.

Other Relevant Discovery Attributes

Another interesting statistic we were interested in studying was the genre of music people were discovering. If we look at the graph in Figure 21 we can see the total amount of discoveries in each genre. The most popular genres discovered were pop and electronic music. This result isn't surprising considering all of our participants were college students and the electronic music scene is becoming more and more popular. The next most popular genres were hip-hop/rap, rock, and country music. Finishing off our genre graph we have a collection of niche genres, a cappella, orchestral, and R&B. One of the most important things we were interested in relation to genre of music was if people were discovering music outside of the genre they primarily listen to. If we look at the top axis in Figure 22 we can see the spread of users across each genre. Surprisingly it's relatively wide spread. There were five users that discovered music in at least two genres (users 2, 5, 6, 7, and 8) compared to three users who only discovered music in one genre (users 1, 3, and 4). Based on this result we can conclude that the majority of our users discovered music outside of their primary listening genre. We can also take a look at how often users said they would listen to a given selection of

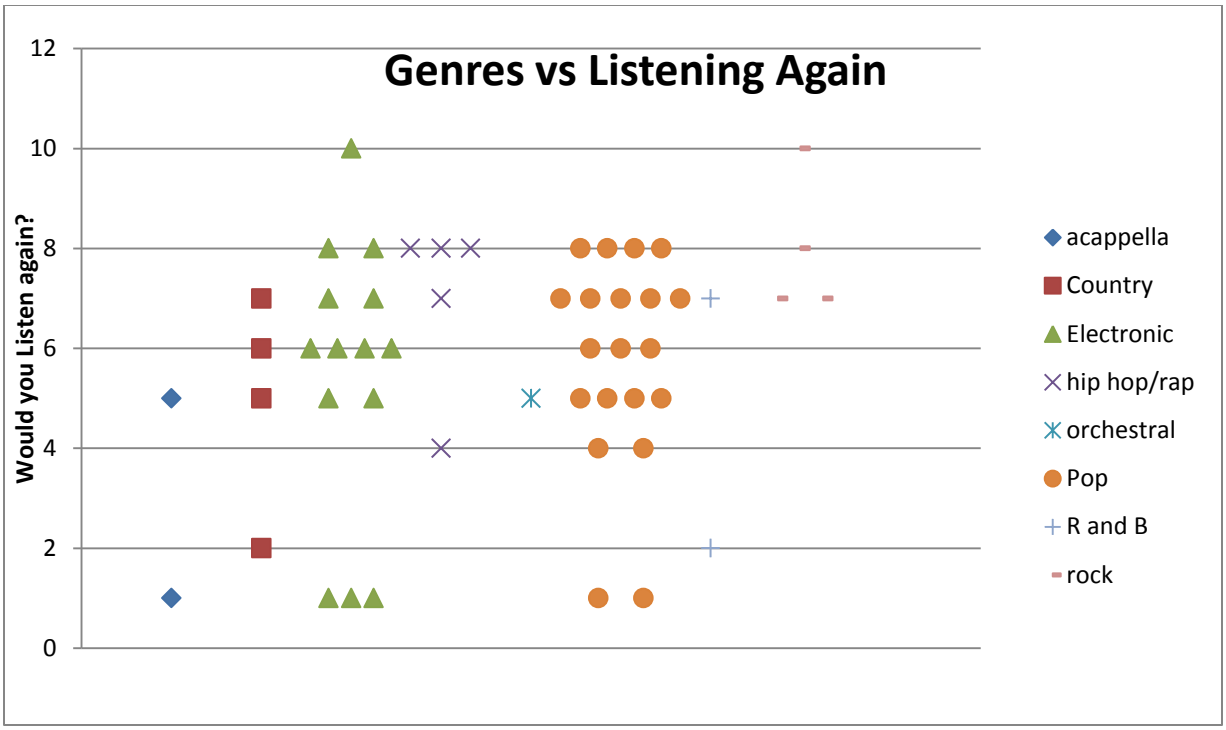


Figure 3 A graph comparing the participants willingness to listen to the music again for each genre discovered

music again in each genre of music discovered. The results for this comparison can be seen above in Figure 3. The distribution varies between each genre but it's the most interesting for the genres with the most responses. If we look at the responses for electronic music we see that they are pretty condensed around a rating of 6 with the same number of responses above and below with a maximum rating of 10 and a minimum rating of 1. Pop music shares a similar distribution but they have more responses above a 6 than electronic music. Pop music's range is also slightly different going from 1 to 8. When looking at some of the other genres like hip hop/rap and rock we can see that although there is a lower quantity of responses the ratings are higher overall. From all of this information we can conclude that electronic and pop music are obviously the most popular genres and are discovered more often however more effective discovery takes place in other genres. Based on this data, when developing a new software it

would be best to advertise new music to users that may be lesser known in regards to popular music because it leads to more effective discovery.

Another area of interest was what people were doing when they discovered new music. The results to this question can be viewed in Figure 23. This data shows that 42% of people discovered new music while they were only focused on listening to music compared to 58% of people who were doing some other activity. The most popular of these activities were housework at 13%, work at 11%, homework at 8%, and watching TV at 6%. So the majority of the music was discovered either while only listening to music or when it was as background noise for some type of work. This is consistent with a couple of our other results for example the devices used for discovery. The computer was far ahead of the other devices in this category and now we can make educated assumptions explaining why. When most people are doing work they're doing on a computer, especially college students, and this is when they are making their discoveries. The same goes for only listening to music. If a college student is home and they want to listen to music they are going to go straight to their computer. Another consistency is in the amount of active and passive discoveries. 58% of people reported their discoveries while doing another activity which would indicate a passive discovery. This leaves 42% of people that could be discovering their music actively or passively. If we look at the actual results in Figure 4 we can see that the majority of discoveries were passive which makes sense when looking at this set of data.

When designing a music discovery software, a question one might ask is what type of discovery is the most popular, the discovery of a song, an artist, or an album. To answer this we

asked this question in our journal study and the results can be seen in Figure 24. In this day and age the results we obtained aren't surprising. The most common type of discovery was the discovery of a song, followed by an artist, and then finally an album. Most software these days give the user the ability to make a playlist of many different artists. This feature arguably led to the death of the album and the rise of artists focusing on individual songs. This data represents this notion. Based on this data, when designing a software it would be intelligent to focus on promoting individual songs before an artist or an album.

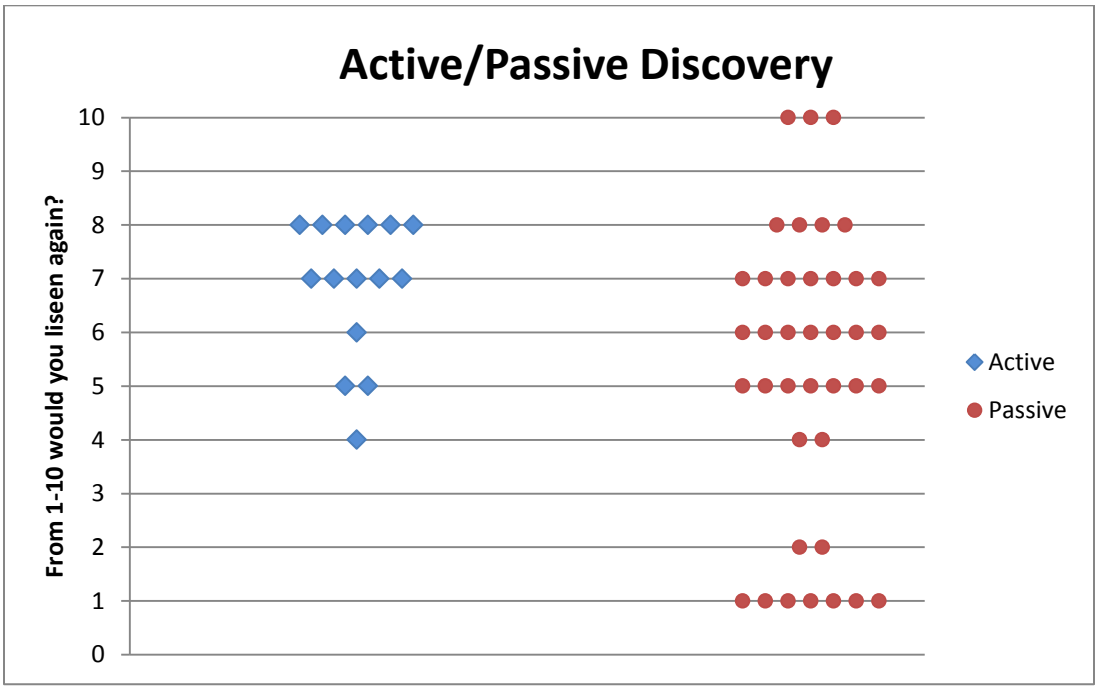


Figure 4 Active versus passive discoveries in the journal study

The graph in Figure 4 shows all of the discoveries that were made in the journal study. The blue diamonds on the left represent active discoveries and the red circles on the right represent passive discoveries. The y-axis represents the likelihood the participant indicated

they would listen to the given song, artist, or album again on a scale of one to ten. As you can see there is an obvious trend for active discoveries. More than 73% of the active discoveries were rated a seven or above by journal participants and there were not any rated below a four. The average rating for active discoveries was a 6.87. When you look at the passive distribution it isn't as straightforward. The highest concentration of ratings lies in the middle with seven discoveries each rated at seven, six, and five. Only 36% of the passive discoveries were rated a seven above. Although the passive discoveries garnered three ten ratings there were also seven discoveries that were rated a one. That's almost 20% of all passive discoveries. The average rating for passive discoveries sits about one and a half points lower than that of active discoveries, at 5.31. From this data we can make a number of conclusions. First we can make the general claim that active discoveries are more effective than passive discoveries because they had a higher average rating, a higher percentage at or above a seven, and a small amount of lower ratings. We can also make the observation that passive discoveries seem rather random based on the distribution from the graph. According to our results there's just as good of a chance, discovering a song passively, that you would likely never listen again (rated a 1) as discovering a song you would be moderately interested in listening to again (rated 5, 6, or 7). The final general claim we will make is that most people discover music passively, as there were thirty-nine recorded passive discoveries compared to fifteen recorded active discoveries.

The last thing we would like to look at is the effect another person had on the effectiveness of the discovery. This includes everything from hanging out with a friend when making the discovery to a friend suggesting the song to you on Facebook. The data can be viewed below in Figure 5. The results aren't apparent right away because the distributions are

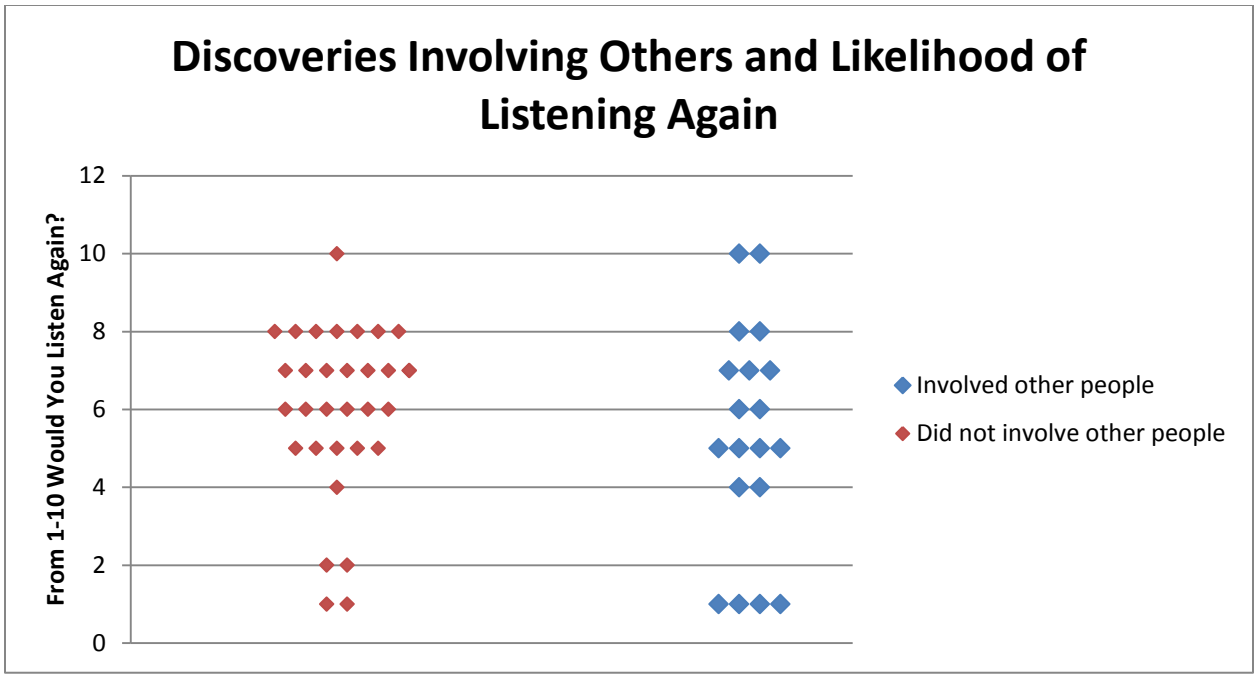


Figure 5 The effectiveness of discoveries that involved other people and those that did not during the journal study

very similar. For both categories the majority of the ratings were between 4 and 8 with an average around 6 or 7. If we actually start to look at percentages however discoveries that didn't involve other people had 67% of their ratings at a 6 or above whereas discoveries that did involve other people only had 47% of their ratings at a 6 or above. From these results we can conclude that discoveries that were made alone were more effective than discoveries that involved other people. We can also see that they occurred at a higher rate. In terms of designing a new music software these results are enough to indicate that there should be a function to share music with others but it shouldn't be the main priority as it isn't as effective.

Survey study

Introduction

When analyzing the survey data some assumptions and analysis choices had to be made. The first analysis choice was regarding an error in our surveying technique. Due to a lack of control over in the survey software we were using, all of our sliders started at 0. The importance of this is that when a person didn't move the slider, it didn't record a response. Upon further investigation asking third parties about our survey, we realized that the survey participants may have been under the impression that if the slider was untouched, that it was the same as rating something zero. As such, for every question, we used two methods for dealing with this problem. The first method was to ignore all untouched sliders and treat them non-responses. The second method was to count all unmoved sliders as zeroes. In almost all cases the results were the same using both methods, but in areas where the results differed, we have discussed both methods. So when a data set is labeled "with zeroes" this means it treats all the non-responses as a zero response, and when a data set is labeled "without zeroes" it disregards all the non-responses all together.

The second analysis decision was to analyze the data in two different ways. One way was to look at the overall average response to any given question. The other way was to split the responses into three groups based on how much music a person listened to in a week. This was done so we could tell the difference between users that listen to music all the time and people that don't listen to as much music. Another decision had to be made regarding the proportions used for splitting the data into these three groups. We chose to use the top 25%, middle 50%, and bottom 25% of users. This was done because the distribution of respondents

to this question was not anywhere near normal and thus, proportions based on standard deviations would not have been appropriate. One statistical resource says “The standard deviation is normally only appropriate when the continuous data is not significantly skewed or has outliers.” (Laerd Statistics, 2006) Due to this we used proportions corresponding to the upper and lower quartiles.

Demographics

When analyzing a survey it is very important to first identify the demographic of your survey population, because the conclusions that can be made from the survey can only be applied to a population of the same demographic of the survey. To determine the demographic of our survey we asked 3 questions.

The first question asked participants what their age was. They were given multiple age groups in to choose from. Given that our survey was mainly sent out to the college community, 69% of our survey population responded that they were between the ages of 18 and 24. The second largest age group was people 45-54 years old. This was most likely due to the fact that our survey was also sent out to the staff and faculty of the university, as well as the alumni. For this reason, our conclusions will need to be limited to people of the ages 18 to 24, as they made up more than two thirds of our population.

The next question regarding demographic was gender. This is also a very important question to ask, especially at an engineering school, because we did not want to be limited in the gender we could make conclusions about. Fortunately, the gender of our survey was split

nearly perfectly. Of the 386 respondents we had, 194 female respondents, 191 male respondents, and one respondent who did not choose a gender.

The final demographic question we asked was about the level of education of the respondents. Once again, due to the fact that we sent this out through the university, 86% of our respondents had at least completed some college, while the rest had completed high school.

With a firm understanding of our demographic, we now know what populations the following observations can be applied to. That population is anyone in the age range of 18 to 24, who has at least completed high school. This means our results look to be firmly aimed at college students in America.

Amount of Music Discovery

The first thing we wanted to figure out was how much music people were discovering. To do this we asked people how many hours music they listen to in a typical week and how many songs they discover in a typical week. People indicated that on average they listened to 22 and a half hours of music every week. They also indicated that on average they discover almost 8 songs per week. From this data we can conclude that on average people discover a new song about every three hours they are listening to music. With this result we have a general understanding of how much people are discovering music and we can keep this in mind throughout the rest of our analysis. If we actually implemented a new software our goal would be to improve upon this number, but since we are just providing suggestions maybe this information would be useful in a future study for comparison purposes.

Discovering music while participating in activities

One of the things we were interested in while doing this study was what people were doing while they were discovering music. To help find this answer we asked two questions on our survey: how often do you listen to music while doing various activities, and how often do you discover music while doing various activities. The results to these questions can be seen individually in Figure 25 and Figure 26 respectively. To be thorough in our research we showed the results when we added the extra zeroes in our data and when we left them out. As you can see when looking at these graphs there were slight differences between the data sets. For the graph in Figure 25 you can see that adding the zeroes to the data decreased the value for homework significantly enough for it to be rated lower than leisure/relaxing. This means that a significant amount of people left the slider to the homework question blank. This is important to note but won't change our overall analysis too much. The same thing can be seen in Figure 26, but the significant difference occurs between partying and traveling/commuting. In this scenario the values are very close to the point where they can be considered essentially even so it won't affect the conclusions we make.

To make conclusions we put these graphs together to compare the differences. This can be seen below in Figure 6. What's key in interpreting which activity is the most effective at discovering new music is looking at the difference between listening and discovering music. You can see that people indicated that they discover the most music while relaxing. When it comes to listening to music, relaxing was around the median. The difference between the two however was the smallest out of every other activity leading us to conclude that relaxing is the

most effective activity for discovering music. If we look at the next activity traveling and commuting

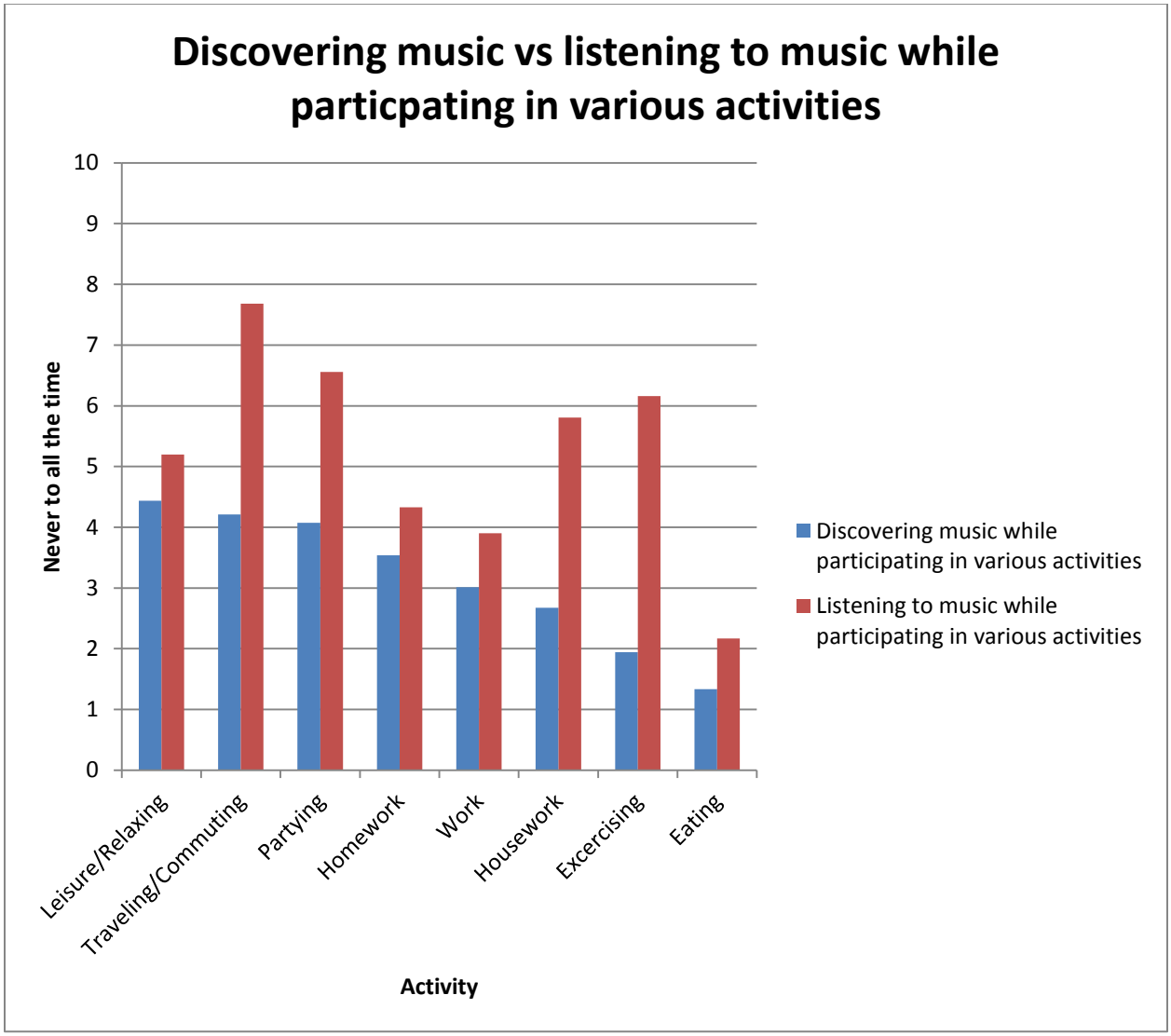


Figure 6 Discovering music vs listening to music while participating in various activities (survey results).

we can see that it was ranked second in terms of discovering new music however the large difference between listening and discovering tells us that overall it's not very effective for music discovery. The same goes for the following activities: partying, exercising, and doing housework. The most effective music discovery activities according to this data is relaxing,

doing homework, and doing work. If we think about this it makes sense logically. If people are engaged in something like partying, exercising, or commuting they aren't going to have the time to look up a song or an artist if they hear something new, they're just going to keep doing their activity. They also are probably using a mobile device like an iPod, or a smart phone which usually have music that's preloaded onto it meaning they have already the music they would be listening to. On the other hand if you're relaxing, doing homework or at work, most people have the access to a computer or are looking to procrastinate. They have the time to look up new music are more likely to be using an internet music service that can bring them new songs.

This result means that when discovering music people are usually solely focused on listening to music. To create the best discovery service possible we should keep in mind that people don't discover music as well when they are engaged in other activities. When creating an app for a mobile device like a smart phone or an iPod it would be best to create a feature that would make it easier to discover a song, for example a button that would save the song to a playlist with one touch or possibly a voice command. This data also suggests that since people discover more music when relaxing we should still put an emphasis on discovering music on computer applications, since most people are relaxing and listening to music while browsing the internet on a personal computer.

How effective music listening devices are at discovering new music

The next category we explored in our survey was focused on finding the most effective devices people are using to discover new music. We asked questions on the survey in the same format as the previous category. There were two questions: one focusing on which devices

people use and one asking how effective each device is. The responses to these questions can be seen in Figure 27 and Figure 28 respectively. As you can see there are some differences in this data as well when considering the extra zeroes we explained earlier. The desktop computer was affected the most by this difference. When we included the zeroes the results for listening to music greatly decreased for both the CD player and the tablet. This allowed the desktop computer to surpass them on the graph. In a similar fashion on the effectiveness graph the smart phone and desktop computer dropped enough to allow the radio to surpass it. Besides these few changes the two data sets kept the same order. We compared the two questions in the graph below in Figure 7.

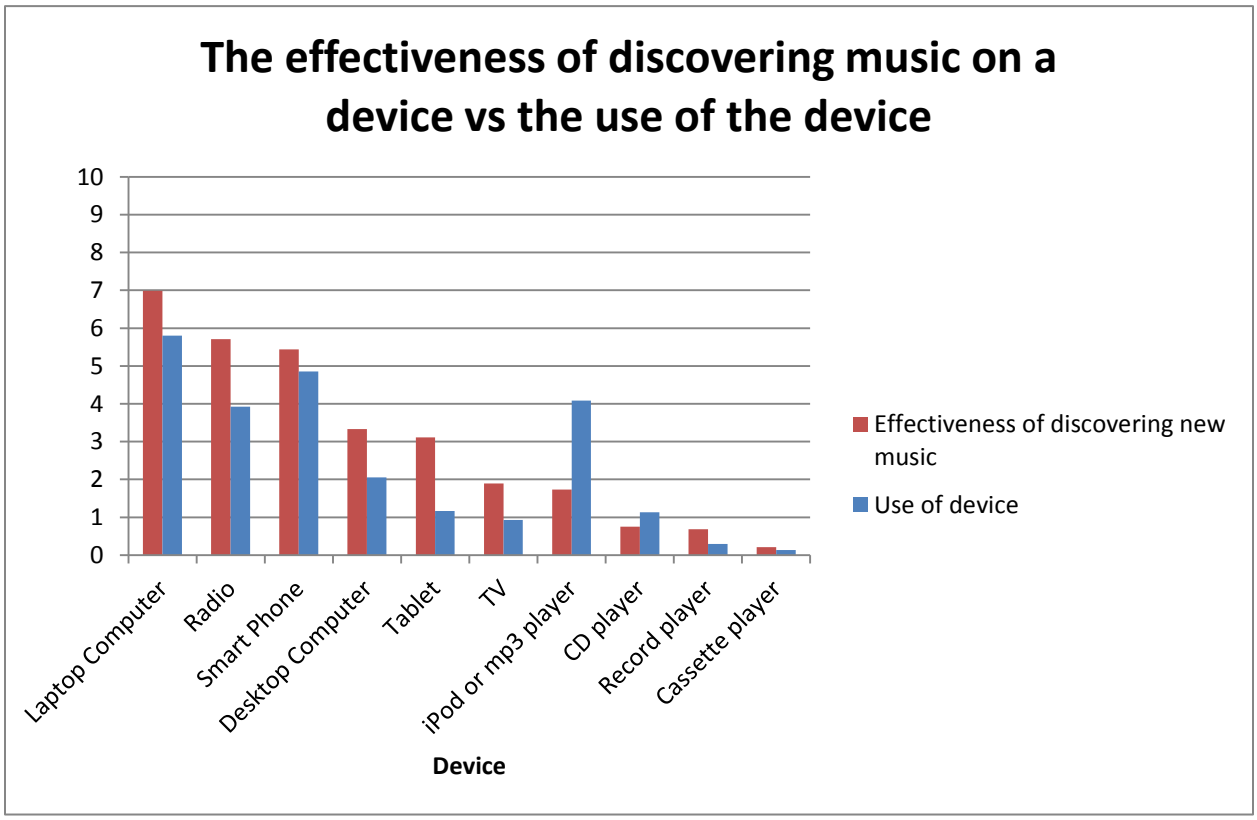


Figure 7 Comparison of the use of a device and its effectiveness in terms of music discovery (responses from the survey).

As you can see the most popular device for both of these categories is the laptop. Especially since this survey involved many college students this result makes perfect sense. When looking at the graph the next highest rated device for discovering new music is the radio, however the use of this device is below that of the smart phone and the mp3 player. If we look at the next device, the smart phone, its effectiveness of discovery was rated only slightly below that of the radio but its use is much more than the radio so we can conclude that it produces more discovery than the radio. So the laptop, the smart phone, and the radio are the most effective in terms of music discovery. The rest of the devices were rated fairly low in both categories and thus aren't as effective. One more interesting point to look at on this graph is the result for iPods/mp3 players. As you can see it's the only device where the use is above the effectiveness of discovery. This is significant because it indicates that although people use IPods and mp3 players a good amount they don't discover music on them nearly as much as the other devices indicating that they aren't an effective discovery device.

We wanted to assess this data further as this question is at the core of our study. We combined some of our other data from other questions to see if we would obtain a consistent result. While we asked survey participants to rate the effectiveness of the services, we wanted to see if their answers to other questions would produce the same result. We categorized people based on the device they listened to most and then compared how much music they listened to overall and how many songs they discovered in a typical week. These were represented in terms of percentage above or below the average. This data can be seen below in Figure 8.

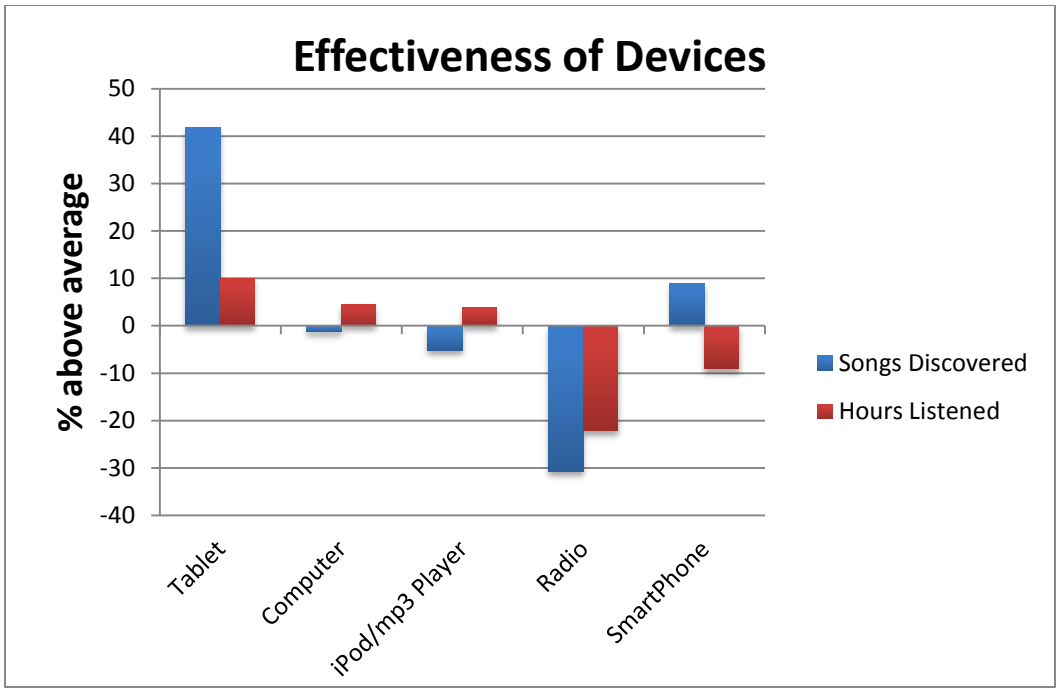


Figure 8 Percentage above or below the total average songs discovered compared to the total average time spent listening to music

The first interesting takeaway from this graph is that of the major devices used, only two manage to let users discover a higher than expected rate of music, based on the number of hours they listen to. Interestingly these 2 devices are both fairly new devices: the smartphone and the tablet. One possible explanation for why these two devices allow users to discover more music are that both modern tablets and smartphones don't allow for the same depth of multitasking that computers do, while offering similar connectivity. This means that users are more likely to be only listening to music, on these devices than on a computer, where users are able to do many other things. Because of this, users are more likely to be focused on finding new music. An explanation for the high percentage of tablet discoveries could be the small sample size. There weren't many people whose most listened to device was the tablet so the few people that did could have skewed the results.

When you look at the effectiveness of the computer the results are consistent with the results we achieved from the other question. Although it appears low on this graph this is the combined results for both desktop and laptop which were resulting in an approximate average amount of songs discovered. The result for IPods and MP3 players are also consistent. This shows that although people are using IPods and MP3 players above the average amount the amount of discovery is below average.

Also of note from the graph is that the radio is a relatively ineffective device for discovering music. This agrees with our hypothesis that users are looking more towards internet services to be able to find new music, but we must look at another graph to see which of these internet services is the most effective for discovering music.

How effective music listening services are at discovering new music

The next set of questions we asked were about how often participants used certain services, and how effective those services were. For this question, we felt it was better to use the method where we split up the ratings by how much music the participants listened to into three groups, top 25%, middle 50%, and bottom 25%. Keeping the same format we asked two questions, one specifying the amount of music listened to on a given service and one rating the effectiveness of discovery on that service. The results for the amount of music people listened to on a given service can be seen below in Figure 9.

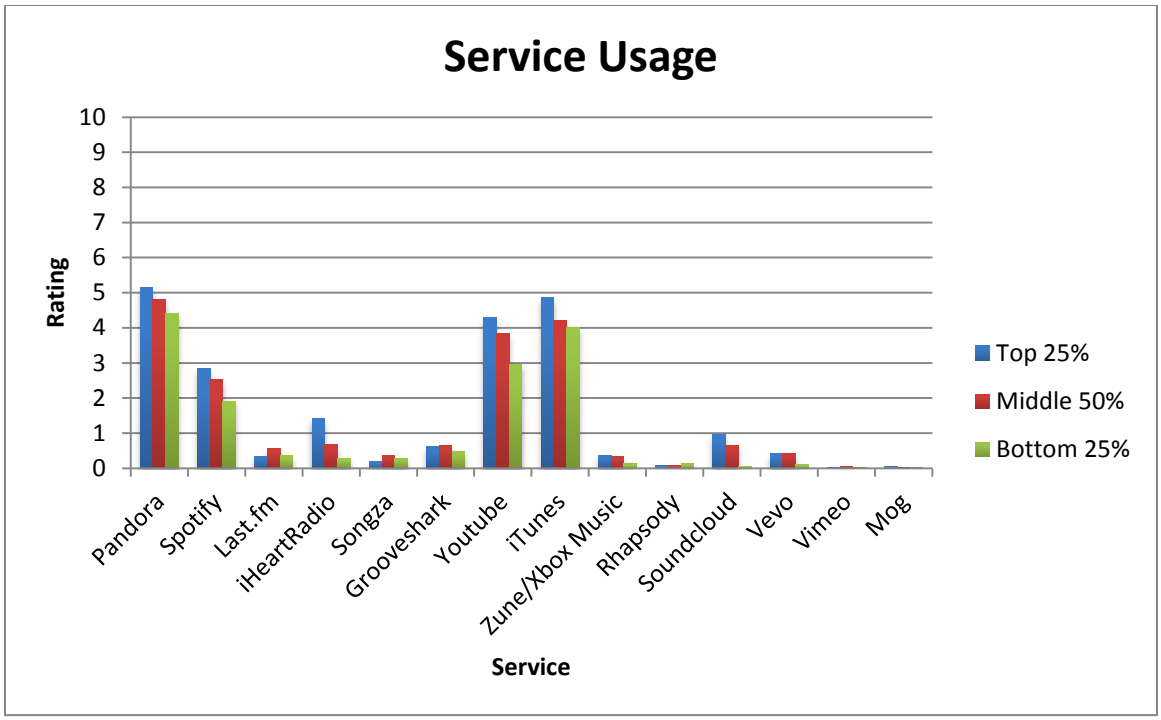


Figure 9 How often people use the following services (responses from the survey).

Some interesting highlights from the graph are that Pandora, iTunes, and YouTube are by far the 3 most widely used services, while Spotify is the only other music service that had a rating above 1 by all 3 groups. One possible reason as to why Spotify sees lower usage rates among our participants is because the service was founded in 2006, while Pandora was founded in 2000. This extra time on the market most likely allowed Pandora more time to gain users.

Another interesting piece of information that can be gathered from this graph is the difference in usage of iHeartRadio between the three groups. While the top 25% of listeners rated the service clearly the fifth most used, the other listeners indicated that they use iHeartRadio no more than most other services. This leads to the conclusion that people who listen to music more are more likely to use more obscure services. This is also highlighted by the

fact that over 15% of the top 25% of listeners indicated that they used some other service not listed, while less than 10% of the rest of listeners said that they used another service.

The follow up to this question asked users to rate services based on their effectiveness, as the participants perceived it. As we'll see later the perceived effectiveness does not necessarily translate to the most discovery. The graph showing the results for this question is shown below in Figure 10.

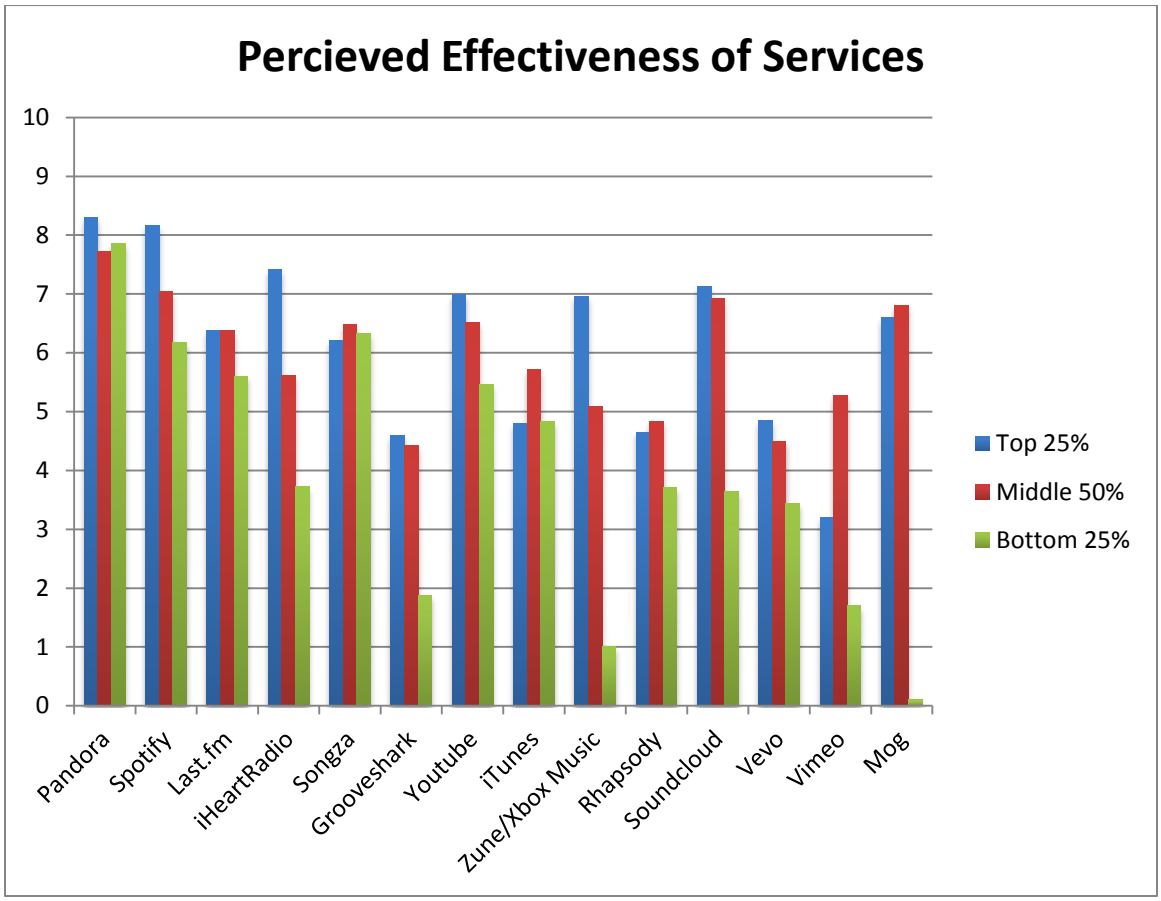


Figure 10 How people rated various services for effectiveness in terms of discovery (results from the survey).

One of the most interesting things to note about this graph is the fact that while Spotify was only the fourth most used service, it was ranked second in effectiveness for discovering

music by all three groups. This leads to a common perception about Spotify that it is very effective for finding new music.

Another interesting point is that Pandora is universally accepted as the most effective music service for discovering music, and is one of the only services that does not seem to have a correlation between perceived effectiveness and how much music somebody listens to. This is interesting to note, as it is the only service of the top 4 most used that functions solely using a radio feature. That is, it is the only service that seems focused 100% on indirect discovery, while services like Spotify and iTunes allow the user to search for music, while also having radio functions, and services like YouTube, require you to either search for a song, or stumble upon it in a video.

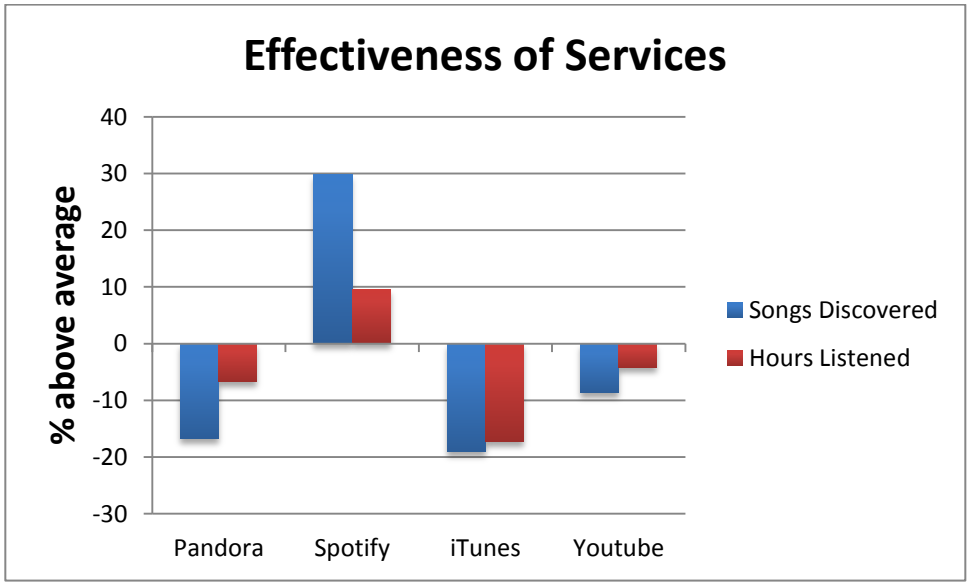


Figure 11 The comparison of the percent above the average of songs discovered on a service to the average amount of time people listened to music

The graph shown above in Figure 11 is similar to the previous graph about devices, except this graph details effectiveness of services. This graph shows a couple interesting things. The first is that both YouTube and iTunes users listen to, and discover less music than average, but that the number of songs discovered is expected given the number of hours listened to.

The second and more important takeaway is the difference between Spotify and Pandora. While Pandora was rated as the most effective service for device for discovering music, this graph shows that that simply isn't true. While both Pandora and Spotify users listen to within 10% of the average amount of music, Spotify users discover nearly 30% above average music, while Pandora users discover just over 15% below average amounts of music. This graph clearly details Spotify as the more effective service for finding new music.

All this data leads to the understanding that music services not only facilitate more music discovery, but also that people believe they discover more music in the modes of discovery that have been commonplace. As was talked about in the background, radio has served as an effective form of passive discovery since it was widely adopted, and people believe that Pandora, which is an Internet radio service, is the most effective of all the current services for finding new music.

The top discovery services all have unique attributes that we could add to a software of our own. Pandora was one of the first successful internet radio services that offered a unique discovery method based off a music genome that would play similar songs automatically. Spotify is a complete software package that offers a wide range of music than can be selected as well as shuffled on a personalized radio section. It connects with social media that allows you

to share music and there's also a unique discovery page that offers suggestions based on prior activity, popular trends, and friends activity. YouTube is a website that offers not only audio but a video which has spurred the creation of lyric videos and helped bring the music video to the digital age. YouTube also offers suggestions on what to watch next based on viewing history and the current video. ITunes is also a software package that offers a wide array of services. It has a radio feature, a new discovery feature, and a huge music store. ITunes is more popular with IPhone and IPod users as they are required to have the software. Another thing worth noting about ITunes is that the music acquired from the program has to be paid for which is significant considering this isn't true for the other services. An ideal program would have a mixture of these attributes as it is clear from our analysis that these services work well.

Genres effect on discovery

Another section of music discovery we explored with the survey was genre. We wanted to see not only what genres were most popular, but also how often people discovered music in each genre. As mentioned earlier, the results for most of the questions were analyzed in two ways: including, and excluding the answers that were left blank, and we will compare the two.

The first question regarding genre asked participants to rate their favorite genres on a scale of 0 to 5 stars. For analysis purposes we later changed the scale for this question to 0 to 10 when we compared the rating to the frequency people discovered new music in a given genre so that both would be on the same scale. When including and disregarding the extra zeroes we talked about earlier, the results were largely unchanged. This graph can be viewed in Figure 29. In both data sets the highest rated genre was rock, with a rating around 3.5. The next closest was pop with an average rating of about 2.8 stars, and the third highest was

interestingly classical with an average rating of about 2.35 stars. After that, the rest of the ratings were within 5% of a 2 star rating except for avant-garde, metal, salsa, and world music which were all lower.

We found this fairly interesting, because while pop and rock are understandably rated highly, classical music was not as expected, especially when compared to some of the other genres there such as country and hip-hop.

The next question we asked was how often participants discovered new music in any of the previous genres including music they enjoyed listening to and music they didn't particularly care for. Once again, both the inclusion of the extra zeroes and disregarding them yielded fairly similar results. This data can be seen in Figure 30. Once again the top two genres were pop and rock. What is interesting to note about the discovery though, is that the rate at which participants discovered pop music slightly edged out rock, whereas rock was rated the favorite genre of participants by a 25% margin when compared to pop music. This piece of information suggests that while there might be some correlation between liking a genre and discovering music in that genre, that the correlation is not perfect. We compared these two questions in the graph below in Figure 12.

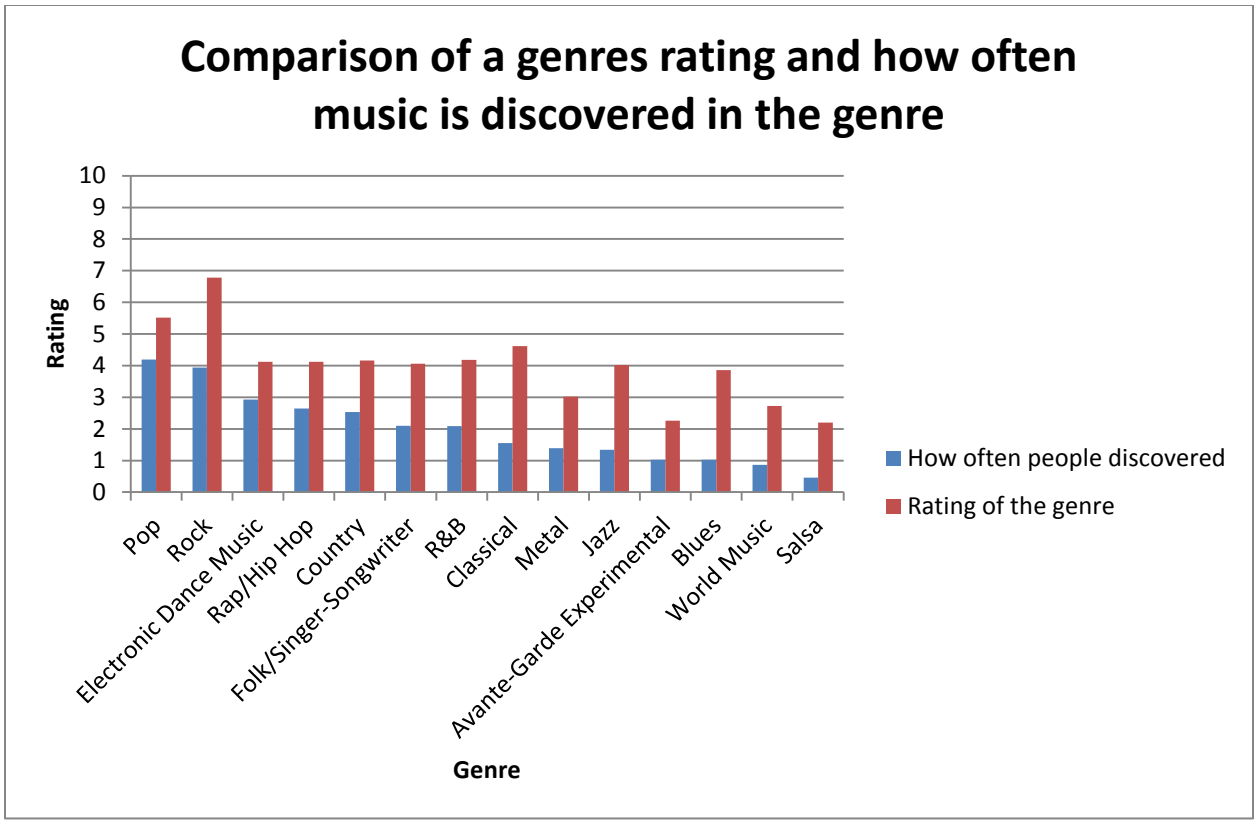


Figure 12 The comparison of a genres rating and how often music is discovered in the genre (results from survey data).

What's also interesting is that electronic dance music and rap/hip-hop were the third and fourth most discovered genres respectively, while they were both middle of the pack when participants were asked to rate them in the previous question. This isn't a huge surprise because electronic music is becoming increasingly popular and Rap/Hip-hop music has been popular for the past twenty or so years. The last interesting piece of information that can be gained from this question is that while classical music was rated third in the previous question, it was rated the ninth most discovered genre. This points to a possible deficiency in current music discovery services, such as Pandora, in finding Classical music for their listeners.

Other relevant topics

A huge part of this study is to see how much music people are discovering actively and passively. So we asked our survey participants this very question. Throughout our research and prior experience we also notice that a lot of people discover music via word of mouth and we were interested in this as well. Since these were all types of discovery we could include them all in the same question. The results can be seen below in figure 13.

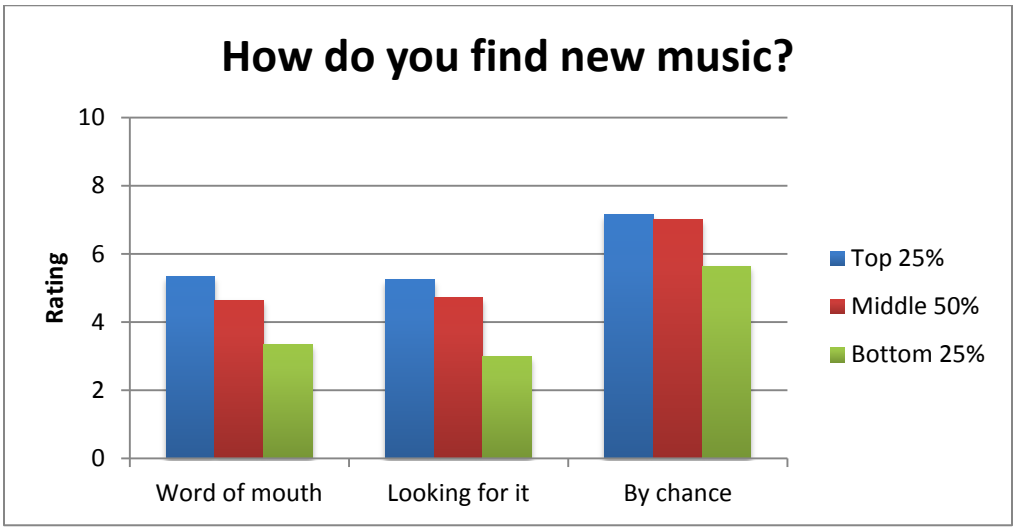


Figure 13 How users found new music.

Looking at this data each group of music listeners agreed that they discover music 20% more often by chance than when they are actively looking for it. It's also interesting to note that respondents indicated that they discover music via word of mouth less than they do when they're actively searching for music or by chance. This was a surprising result as our perception was that word of mouth was still very effective in discovering new music. It's possible that although respondents discover less music via word of mouth that the quality of their discoveries are higher and that they would listen to that music more but it's impossible to determine with our data, further research would have to be done.

To get a general feel for how people view new streaming services, a topic central to this study, we asked our participants to rate on a scale of 0 to 10 how much easier music discovery services have made finding new music, 10 being easiest, 0 being hardest, the average rating was a 7.9. When asked if they discover more new music, less new music, or the same amount of new music since the advent of streaming services, 69% said they find more new, music while 27% said they find the same amount. That leaves a 4% total who believe they find less new music since discovering music streaming services such as Pandora and Spotify. So the general feeling from our audience was that streaming services have made finding new music easier and as a result they discover more music.

Comparing the results of the journal and survey studies

The most popular devices used for discovery was pretty consistent throughout each phase of our study. The computer was the huge favorite for the journal study as it was for the survey study. During the journal study the rest of the devices did not record much discovery in comparison. The results of the survey however revealed that in addition to the computer, smart phones and the radio were effective in terms of discovery. Our survey allowed us to receive a greater number of responses so the two sets of data aren't conflicting but rather complement one another. We can conclude that both studies were accurate and that the most effective devices for discovery were the computer, smart phone, and radio.

Next, we will compare the services used for discovery in both studies. In the journal study the top two music services were Spotify and YouTube. We were able to make the distinction that although Spotify was more popular, YouTube was more effective in terms of

discovery. Pandora was not mentioned at all in the journal study and ITunes was only sighted in four discoveries. In the survey study Spotify, Pandora, ITunes, and YouTube, were the most popular services. Based on the data from our survey we were able to conclude that Spotify was the most effective service even though Pandora was perceived as the most effective. Once again these studies complement one another nicely proving that these four are the current music listening and discovery giants despite slight differences between the two studies.

In the journal study the most popular genres that were discovered were electronic and pop music. The journal study also led to conclusions that more effective discovery took place in other genres, not the two most popular. In the survey pop and rock music were the most popular while the most discovered genres were rap/hip hop and electronic. This is consistent with the journal study that the most popular genres weren't discovered as much as some of the others. The discrepancy in most popular genre is probably due to the small sample size of the journal study. So from this we can verify our conclusion that more effective discovery takes place in the least popular genres.

The most popular activity for discovering music in both studies was leisure/relaxing. The next most popular activities in both studies were work, and homework. Housework was split, having been determined effective in the journal study but ineffective in the survey. All other activities including, watching TV, playing video games, partying, and exercising were fairly ineffective for discovering new music. There was only one conflict between the studies which again can be explained due to the small sample size in the journal study. The fact that activities

where you are actively involved in something aren't effective for music discovery was consistent throughout each study.

Another consistency in data between the two studies was the effectiveness of active and passive discoveries. Although passive discoveries occur more often, active discoveries are more effective.

Finally, we these studies both suggest that music streaming and online music services have made music discovery easier and more effective. In the journal study these types of services were the most popular and in the survey people indicated this explicitly.

5 Conclusions and recommendations

Summary

To study the effect music listening technology has had on music discovery we first did research on popular music listening devices of the past. Noticing the effects they had on music discovery made us curious as to what effect modern technologies have had. We did some research on this matter as well and took it upon ourselves to commence our own study. To accurately assess the effect new devices were having we decided to break our study into two separate parts. One part was a journal study that invited twenty peers to record their music discovery experiences in a small journal that they could keep with them at all times. The second part was a survey that was open to all audiences. The goal was to be able make widespread general claims with the survey study and to make more specific claims when looking at individuals. Although we handed out twenty journals we only received eight back at the conclusion of our study leading to problems with a small sample size. We achieved our respondent goal with our journal study, receiving three hundred and ninety responses. The majority of our responses were from the college community including undergraduate students, graduate students, and employees. Although this is a rather centralized demographic, we believe it best describes the music services we were studying since college students are usually using the latest technologies.

The data from each survey was then compiled together using Microsoft Excel and analyzed. Graphs were produced for each question asked in the journal and survey studies. We were also able to compare certain questions where it was relevant resulting in conclusions

regarding music discovery. After looking at each study individually, we compared the two studies and found that they complemented one another. Most of the data was consistent and we found that the survey data was, for the most part, an expansion of the data obtained from the journal study. Having a solid understanding of the data we obtained we were then able to make recommendations for a potential music discovery service.

Conclusions/Recommendations for a potential music service

Given all the data we have accrued and the analysis we have done, we feel that we can recommend an optimal music listening technology. This technology will not be a physical device but rather a service that will be offered on devices that have access to the internet. This is due to the fact that devices whose purpose is solely listening to music such as the CD player, IPod, and cassette player are being phased out in terms of popularity. The most popular music listening and discovery device was the computer. When developing a new service, software should first be developed for the computer because it will be the most useful. Then an application for smart phones, including both the IPhone and Android based phones, should be developed. As a result an app for the tablet and IPod would be next as it is essentially the same thing.

The software will need to have a very basic user interface most likely similar to that of Spotify or ITunes. The user interface is an aspect which we did not study in detail but we are basing off of popular services. In a future study this would be looked at more in depth to provide the optimal experience. It will have all the features listed plainly so that they can be selected with ease.

The features we recommend are taken from the most popular and effective services. One of the most important features is the ability to connect to other web sites, especially social media web sites. One of the results from the journal study was that most of the people found music that was recommended to them from a friend on Facebook or Twitter. The majority of people have a Facebook account and other social media sites such as Twitter and Instagram are on the rise. Social media web sites allow information to be transmitted very quickly to large audiences. They can also snowball music discovery if a video or a song becomes viral and is shared by multiple people. Spotify allows you to connect your Facebook profile to your Spotify account, but our service would ideally allow you to connect to YouTube, Facebook, Twitter, and any other popular social media outlet. Since these web sites allow you to "like" or "follow" different artists this information would be transferred over to the software. The connection to YouTube would be a little different and would perhaps require its own section of the software.

YouTube, found to be one of the most effective music discovery mediums, has a feature that every other service doesn't: video. More recently record companies are not only producing music videos, but they're releasing lyric videos, and studio updates. Lyric videos have grown in popularity especially when people are discovering the music because they're curious what the lyrics to the song are. Since YouTube already has these videos in a huge database of their own, it would be most convenient to have a section of the software that would have YouTube videos based off of past music listened to or music that you have "liked" on other social media outlets. The direct connection to YouTube would be unique to any music service that is currently offered.

There would also be a “discovery” feature. Similar to the discovery feature in Spotify, it would be a list of recommendations based off of past listening. The recommendations would include anything from songs, albums, artists, genres, and YouTube videos. Additionally these same recommendations would pop up on the side whenever you were listening to a song in a similar fashion to the way YouTube videos are recommended when watching a YouTube video. This would allow for further discovery of music.

Another key feature that would be included in the software is the radio feature. We have confirmed that radio is an effective means of discovery as well as radio services like Pandora, ITunes radio, and Spotify radio so it would have to be included in our software. The radio service would automatically shuffle through songs based off an artist, album, song, or genre. It would also have a feature play songs in different genres that had previously showed a trend linking it to a particular song, artist, album, or genre. We decided to include this because, based off our journal study, people enjoy discovering music in different genres other than their primary genre.

There would also be an option to listen to any music you would like. You could search for any song, album, or artist and find specific songs that you already know. If you would like you would have the option to buy the music. Since ITunes is still a popular service and all their music has to be purchased, some people still enjoy owning their music as opposed to streaming it. Buying the music would give you the option to download it to your personal files.

Another popular feature would be playlists. You would have the ability to create a playlist with any combination of songs. These playlists could then be shared with your social media friends increasing the chance for discovery.

When specifically looking at a mobile version of the service, for instance an app that you could download for your IPhone, Android device, or tablet we believe that music discovery should be easy. For most services out now you have to go through the service and navigate to different menus to save a song to a playlist. In our research we found that most people don't discover much music while they are actively engaged in an activity, for example working out. With our service there will be a built in playlist called "listen to again." If you hear a new song all you have to do is press one button and it will be saved to this playlist so that you can come back to it later when you aren't busy. This way you won't have to navigate menus and stop you're activity.

This is a general outline to a music service that we think would be optimized to discover new music. It's essentially a mix of all the most popular and effective music services that we determined in our research. It also has some unique features based off other research questions we had asked.

Recommendations for a future study

If this study was repeated we would recommend making some significant changes to the journal study. We only received eight journals back out of twenty participants which affected our results. If participants had a greater incentive and were monitored closer the results of the journal study would have been more abundant and more accurate. We were not

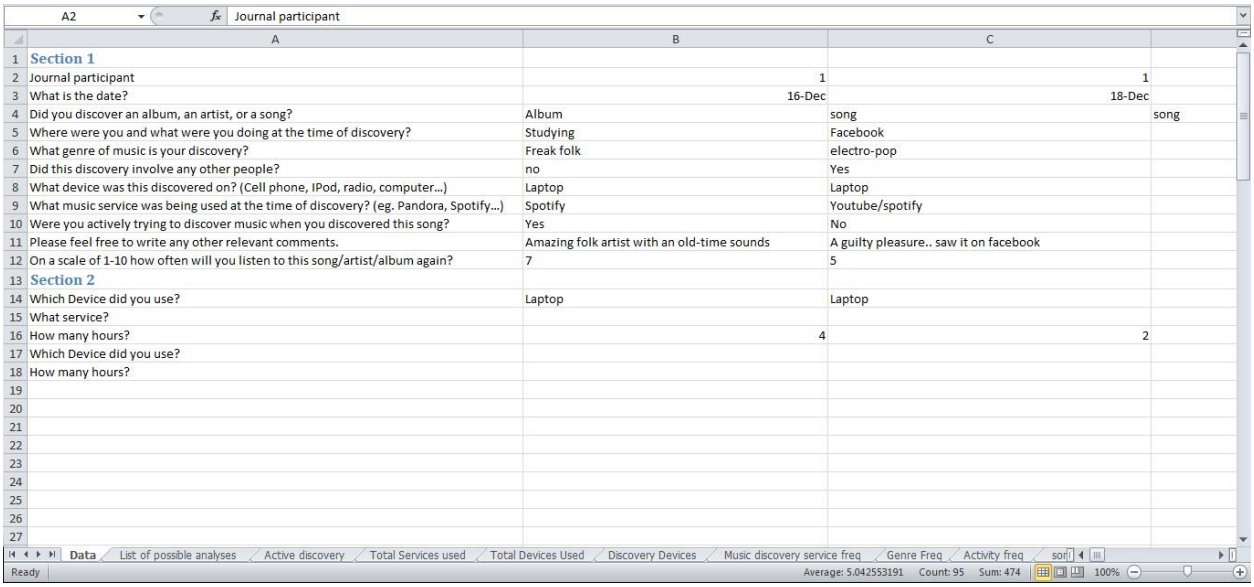
able to do this due to our limited resources as college students but this would have helped the study tremendously. If the survey portion was repeated we would recommend either using a different software or being more specific in the instructions of the survey. Due to a technicality in the survey software many of the sliders for our questions were left untouched and didn't return an answer. These responses could be interpreted as either a "0" response or as a skipped question. Due to this error we had to analyze two sets of data. Although the differences in the data were not significant these weren't the ideal conditions for analyzing data. We would also recommend studying a wider audience. Although we feel our audience accurately represented the modern music services and devices it was still limited for the most part to WPI's campus due to our limited resources. If this study was repeated to a wider audience the results would better reflect people as a whole.

If the intent for a future study was to create an optimal music discovery service we would recommend studying the finer aspects of a music service. The programming involved, the user interface, the navigation, and the fine details would all need to be ironed out to actually create this software. It would also be interesting to study the individual features of each program so that you could take the best features from each service instead of simply combining the most popular music services. To do this you could include questions in your survey or journal study asking people about the individual features or you could create a separate study altogether. Now that we have identified the most popular services, you could have different people listen to only one service at a time and record their music discovery habits. This would give you the most accurate representation of how effective each service was

at discovering new music. These further, more in depth studies would be great to supplement our initial study and would produce a more refined result.

Appendix

Appendix A – Relevant figures



	A	B	C	
1	Section 1			
2	Journal participant	1	1	
3	What is the date?	16-Dec	18-Dec	
4	Did you discover an album, an artist, or a song?	Album	song	song
5	Where were you and what were you doing at the time of discovery?	Studying	Facebook	
6	What genre of music is your discovery?	Freak folk	electro-pop	
7	Did this discovery involve any other people?	no	Yes	
8	What device was this discovered on? (Cell phone, IPod, radio, computer…)	Laptop	Laptop	
9	What music service was being used at the time of discovery? (eg. Pandora, Spotify…)	Spotify	Youtube/spotify	
10	Were you actively trying to discover music when you discovered this song?	Yes	No	
11	Please feel free to write any other relevant comments.	Amazing folk artist with an old-time sounds	A guilty pleasure.. saw it on facebook	
12	On a scale of 1-10 how often will you listen to this song/artist/album again?	7	5	
13	Section 2			
14	Which Device did you use?	Laptop	Laptop	
15	What service?			
16	How many hours?	4	2	
17	Which Device did you use?			
18	How many hours?			

Figure 14 An example of the journal study data

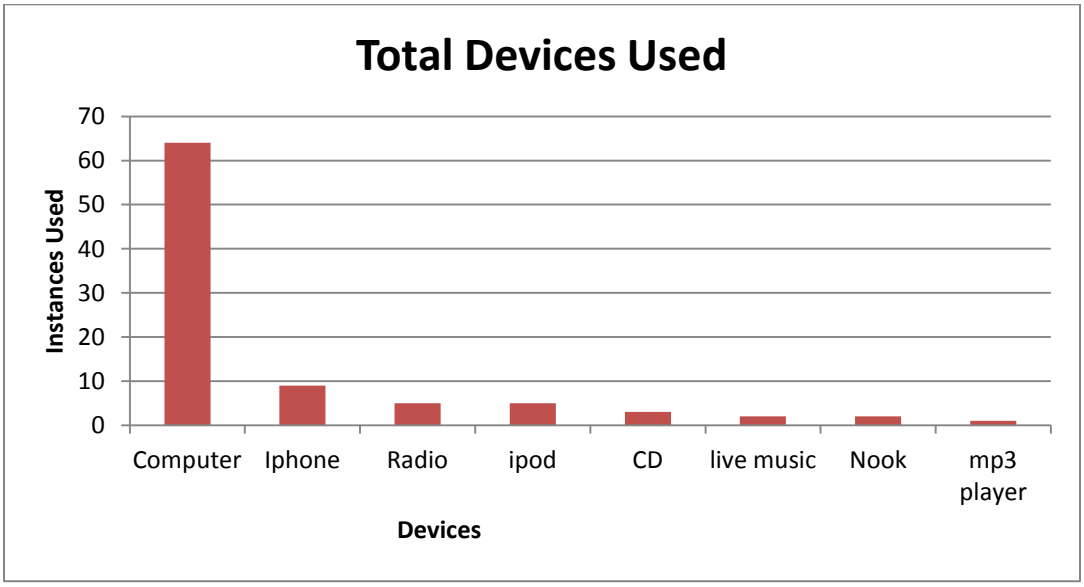


Figure 15 Total devices used during the journal study

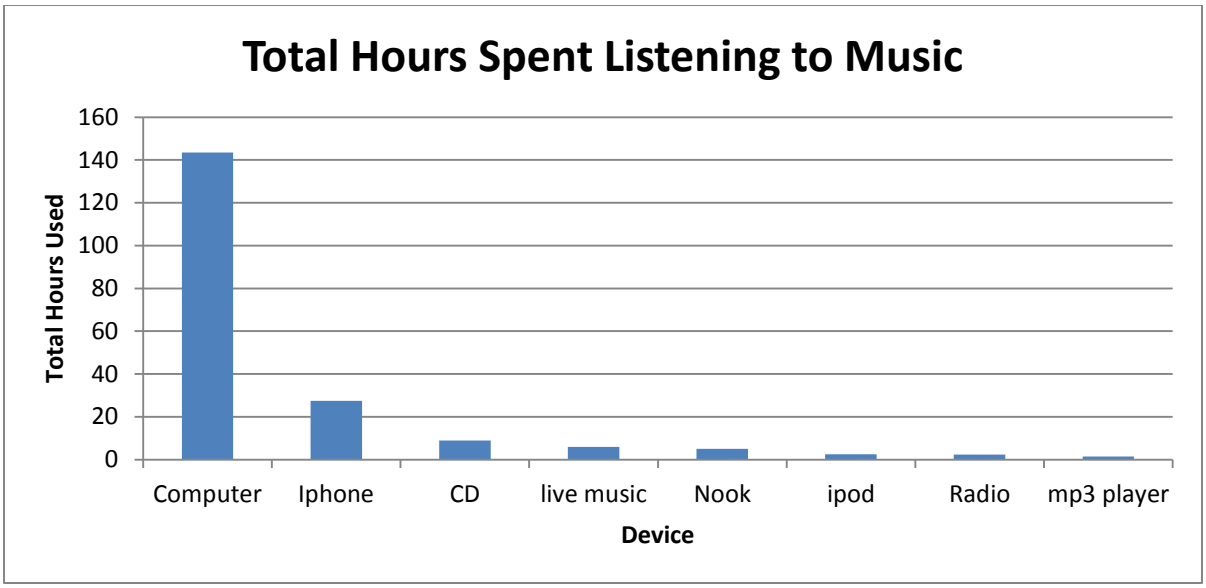


Figure 16 Total hours spent listening to music during the journal study

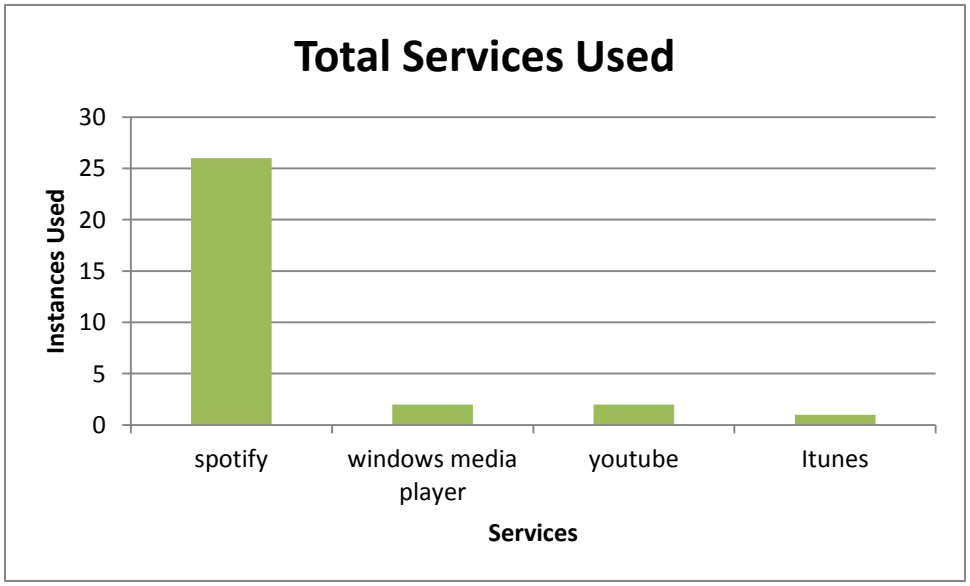


Figure 17 Total services used during the journal study

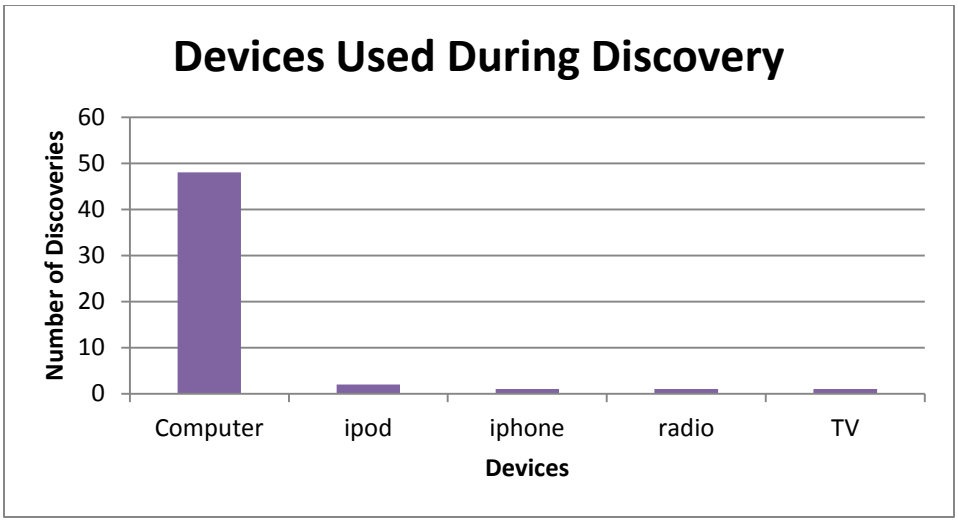


Figure 18 Devices that were used for discovery during the journal study

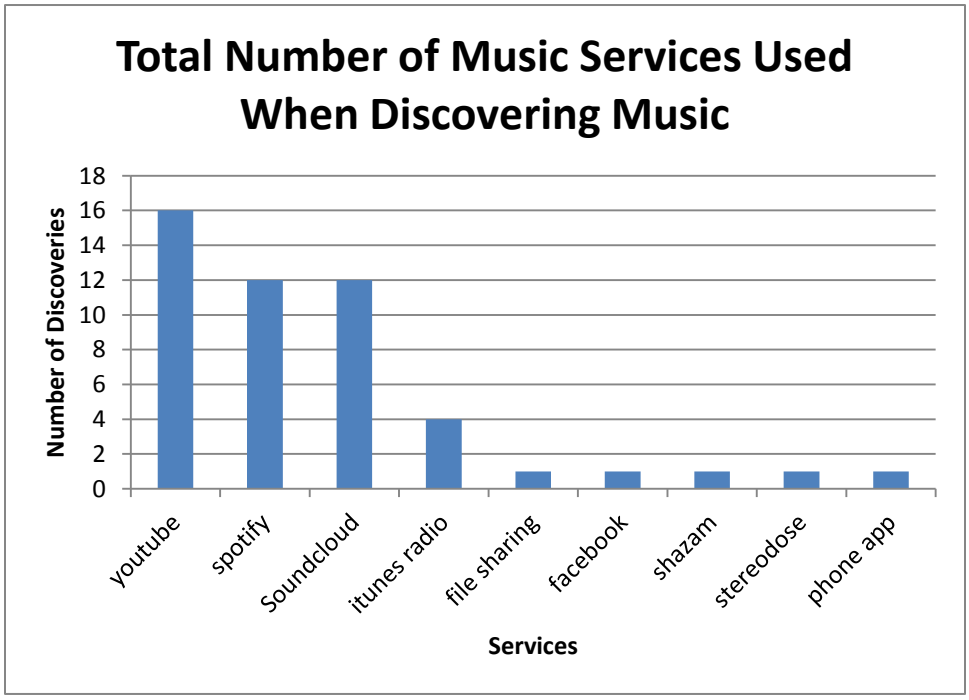


Figure 19 Music services used for discovery during the journal study

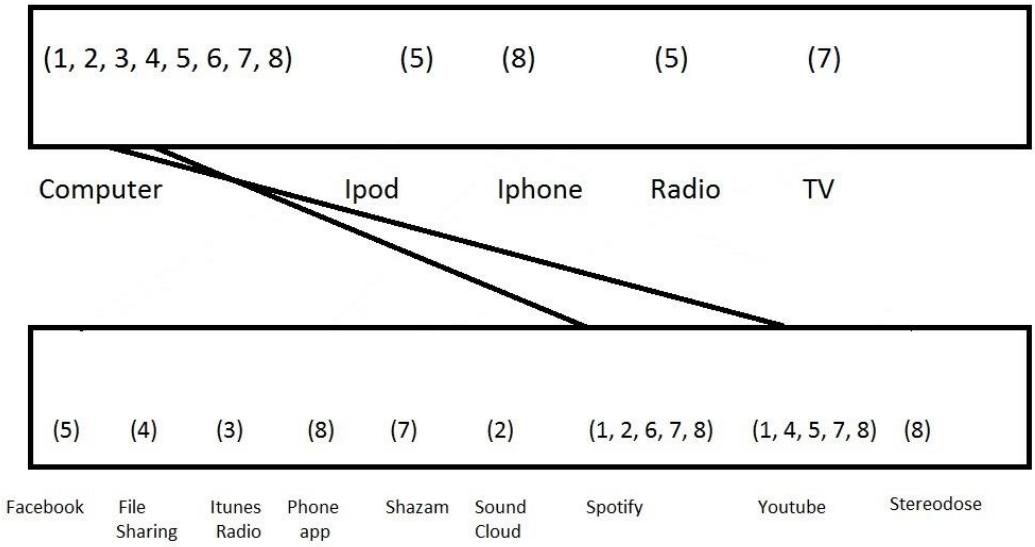


Figure 20 Variable axes analysis done for the journal study. Top: Devices used for discovery. Bottom: Services used for discovery

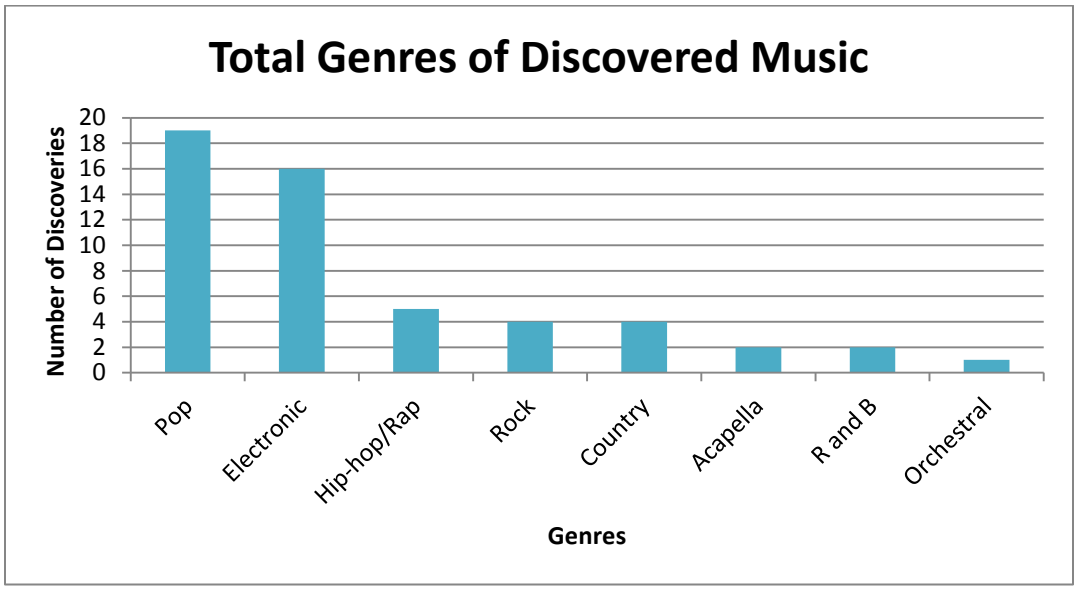


Figure 21 Genres discovered in the journal study

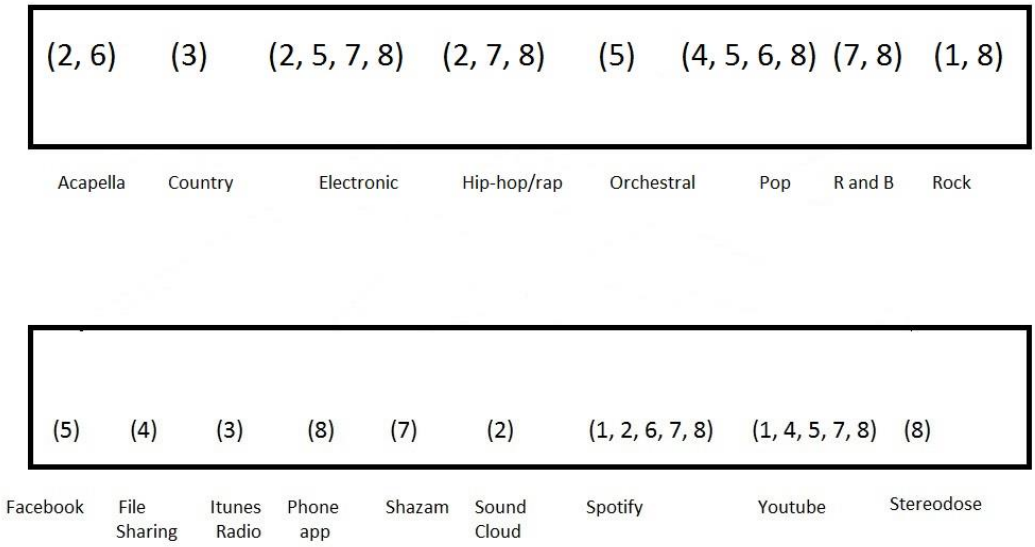


Figure 22 Variable axes analysis done during the journal study. The top axis is genre of discovered music. The bottom axis is music service used.

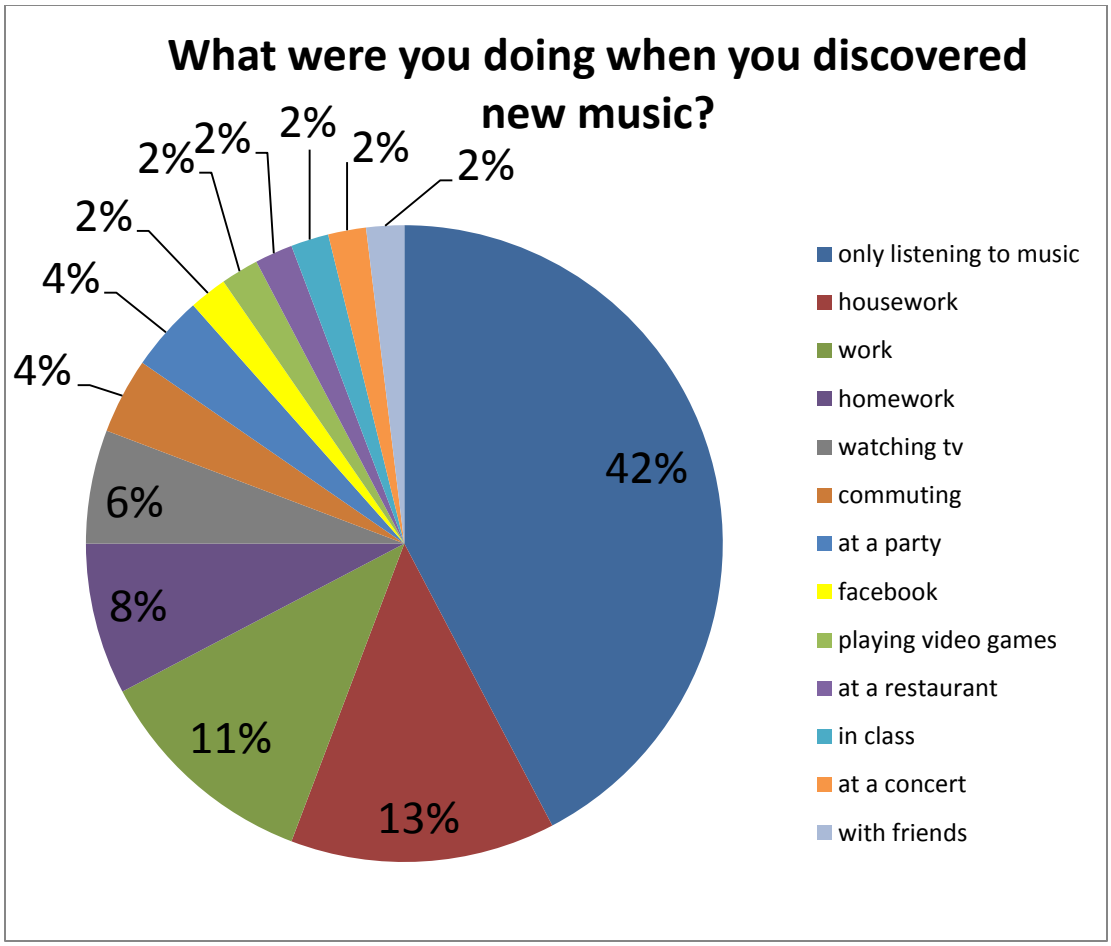


Figure 23 What people were doing when they discovered new music in the journal study

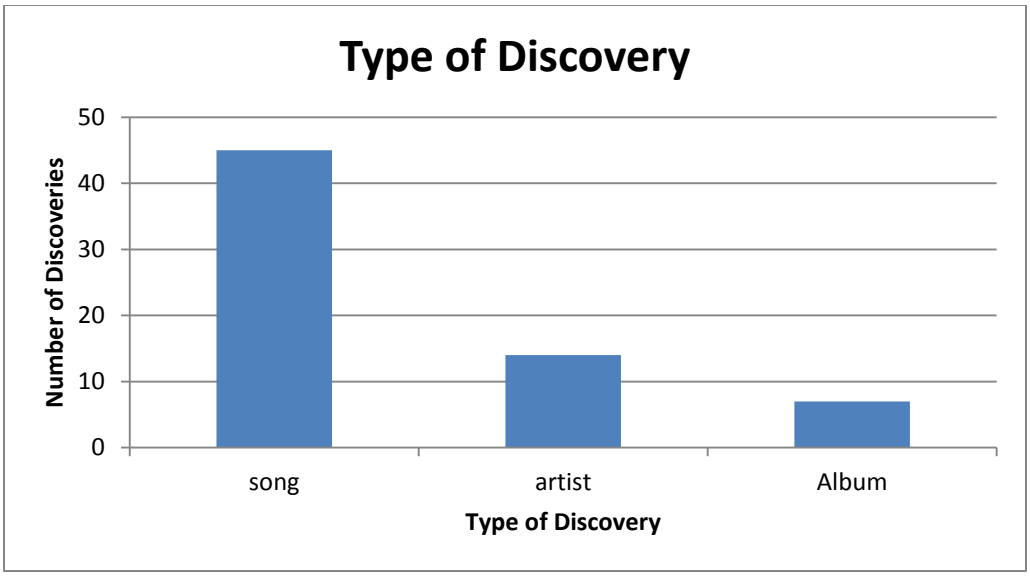


Figure 24 How many discoveries were related to songs, artists, or albums

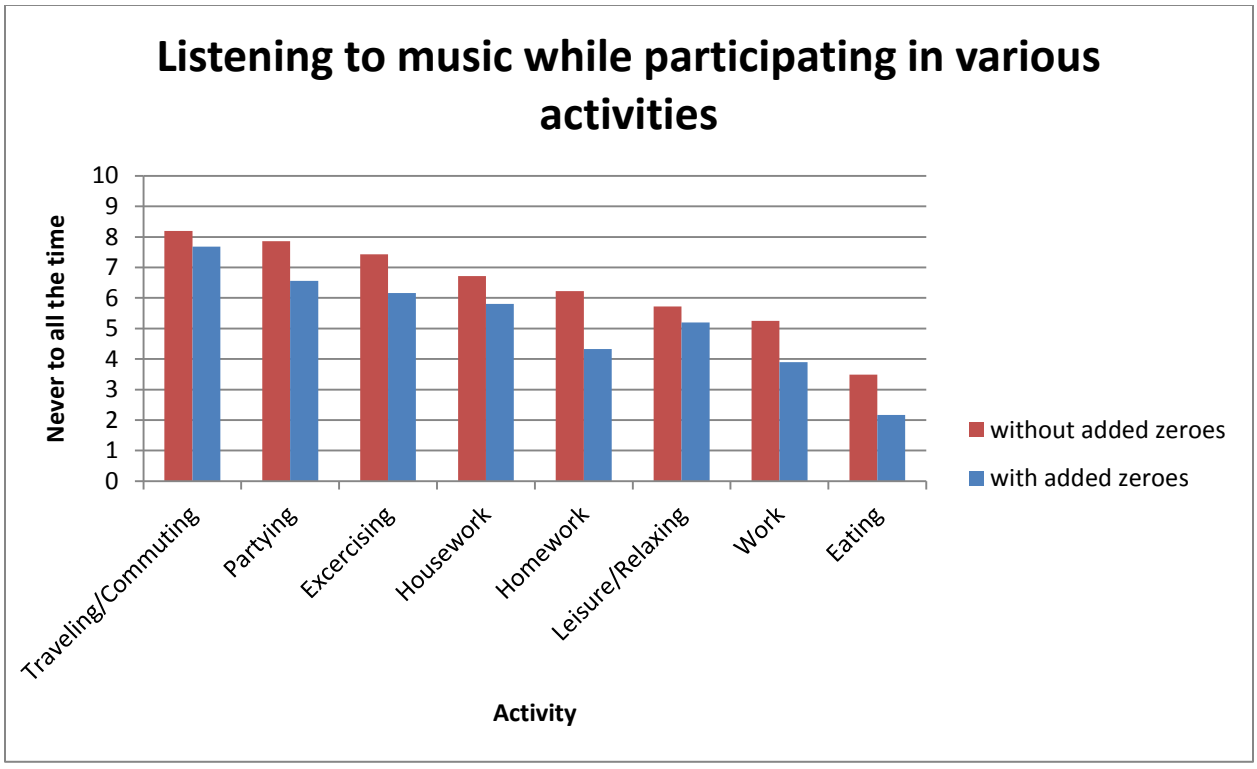


Figure 25 Listening to music while participating in various activities responses from the survey.

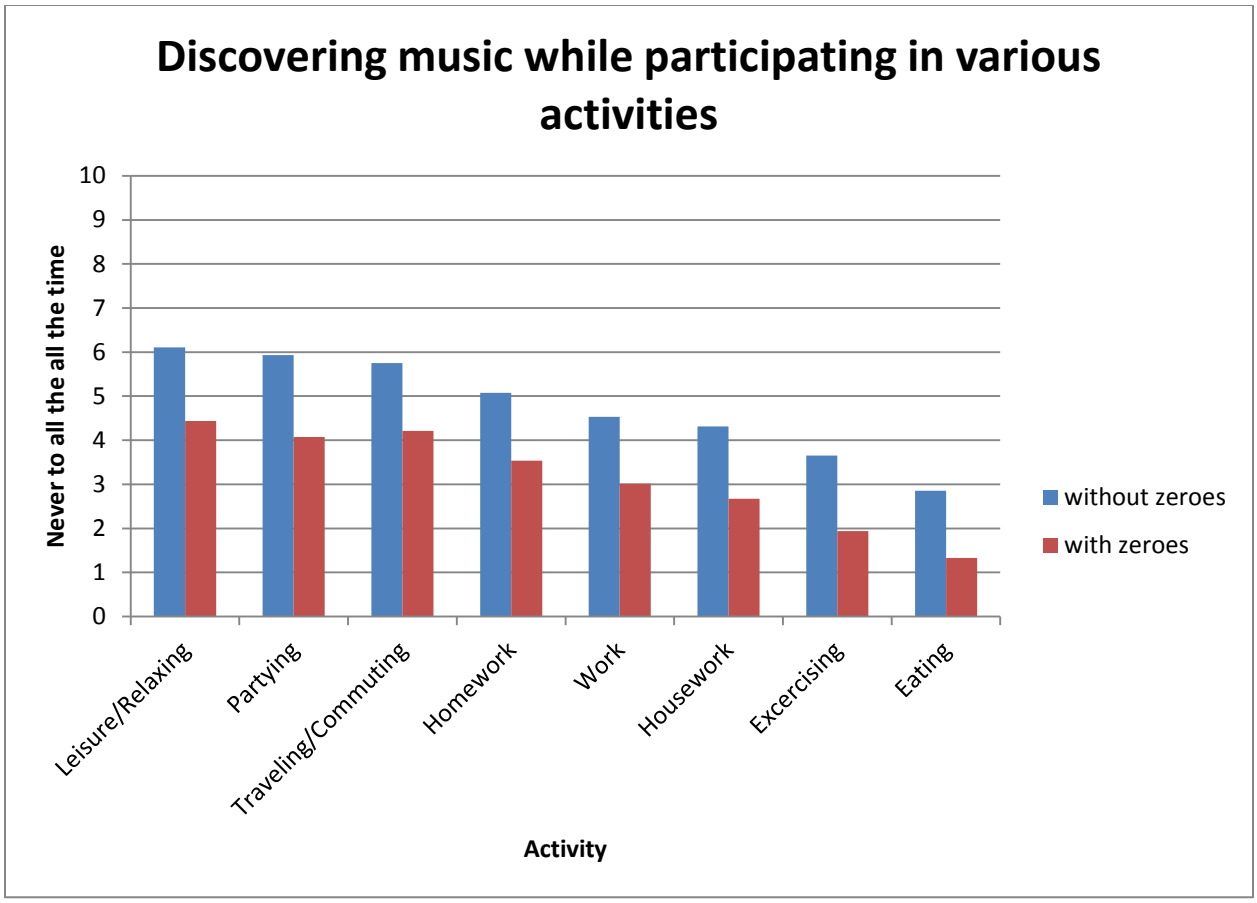


Figure 26 Discovering music while participating in various activities responses from the survey.

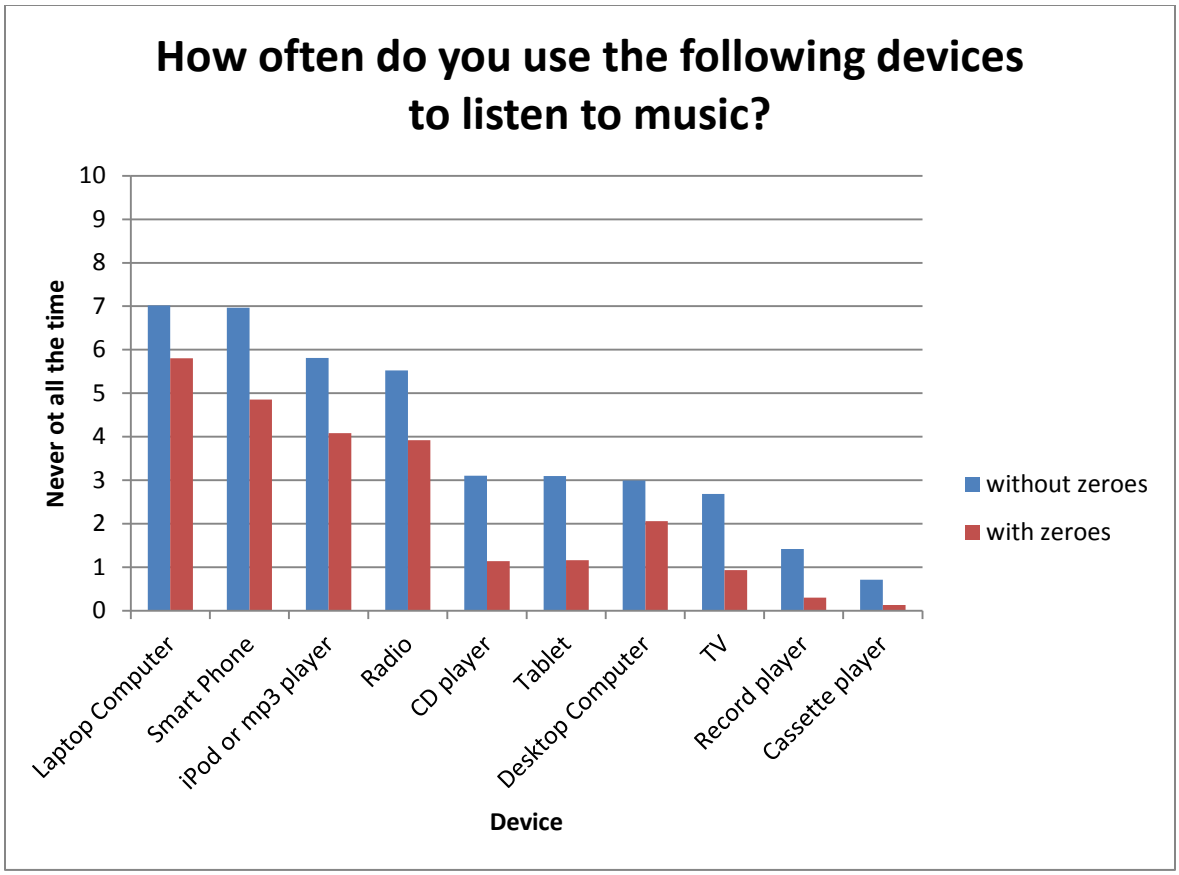


Figure 27 How often do you use the following devices to listen to music (responses from the survey).

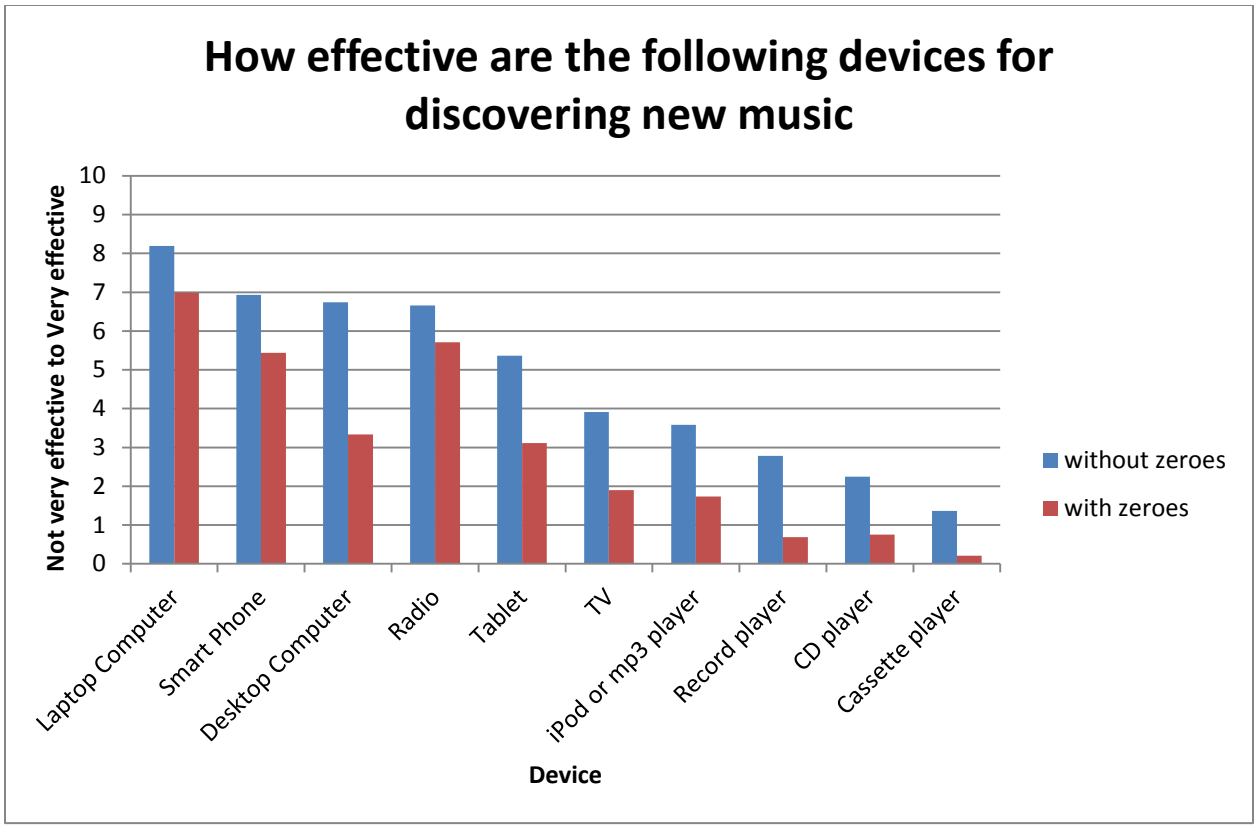


Figure 28 Effectiveness of music listening devices when discovering new music (responses from survey).

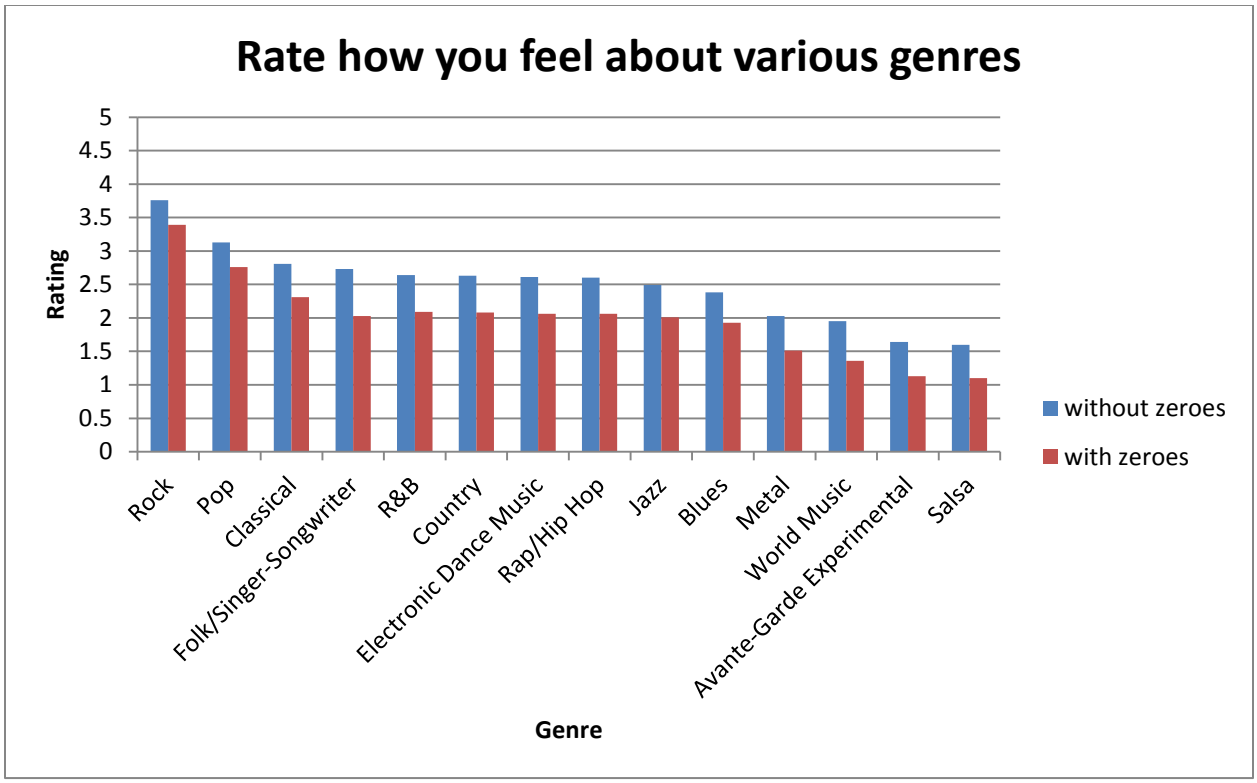


Figure 29 How people rated various genres when asked on the survey

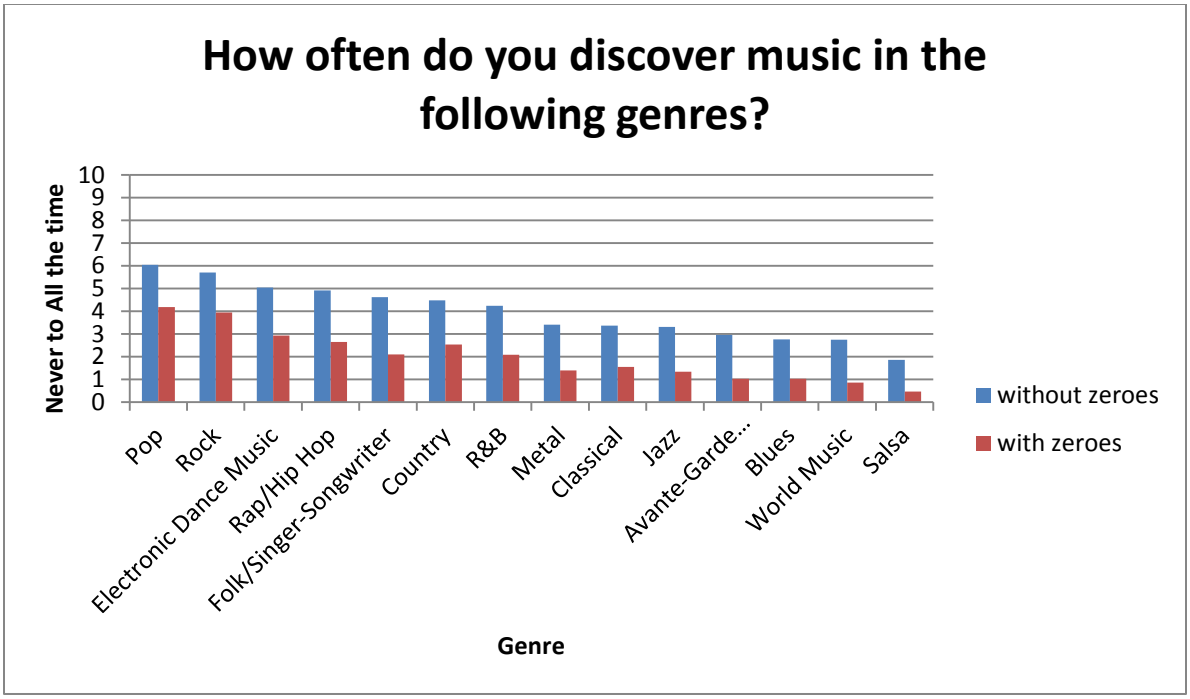


Figure 30 How often people rated they discovered music in various genres

Appendix B—Journal Template

Music Discovery Journal

Hello eager participant! First we would like to thank you for helping us out with our study. Now were going to detail what you should be writing in this journal. On the first page you should write down your age, your gender and a brief paragraph description of your previous music experiences including what type of music you listen to and what devices you primarily use. Whenever you discover a new song of any kind open up your journal and jot down short answers to the questions that are provided in the first section below. If some of the questions don't apply simply leave them blank. At the end of every day we would like you to answer another set of questions that are detailed in the second section. Finally, at the end of the study we would like you to write a brief summary of your experiences at the end of this journal. This may include things that you learned, things you liked or disliked about the study, how the study could be improved and any other general experiences. Once again, thank you and happy listening!

Section 1

1. What is the date?
2. Did you discover an album, an artist, or a song?
3. Where were you and what were you doing at the time of discovery?
4. What genre of music is your discovery?
5. Did this discovery involve any other people?
6. What device was this discovered on? (Cell phone, IPod, radio, computer…)
7. What music service was being used at the time of discovery? (eg. Pandora, Spotify…)
8. Were you actively trying to discover music when you discovered this song?
9. On a scale of 1-10 how often will you listen to this song/artist/album again?
10. Please feel free to write any other relevant comments.

Section 2

1. List the devices that you used to listen to music today and next to the device approximate how many hours you listened to music on that device.

Appendix C—Survey

WPI

What is your age?

- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 and older

What is your gender?

- Male
- Female

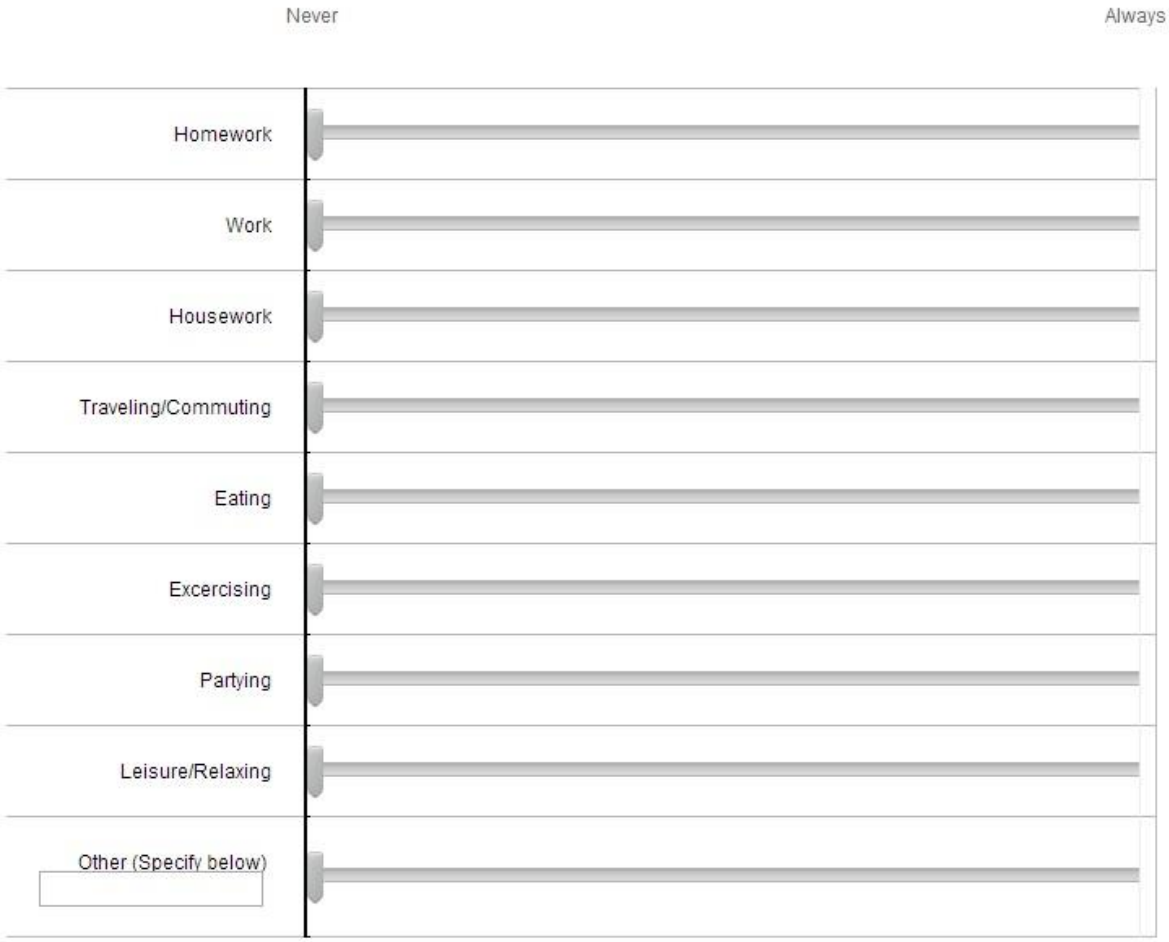
What is the highest level of education you have completed?

How many hours of music do you listen to in a typical week?

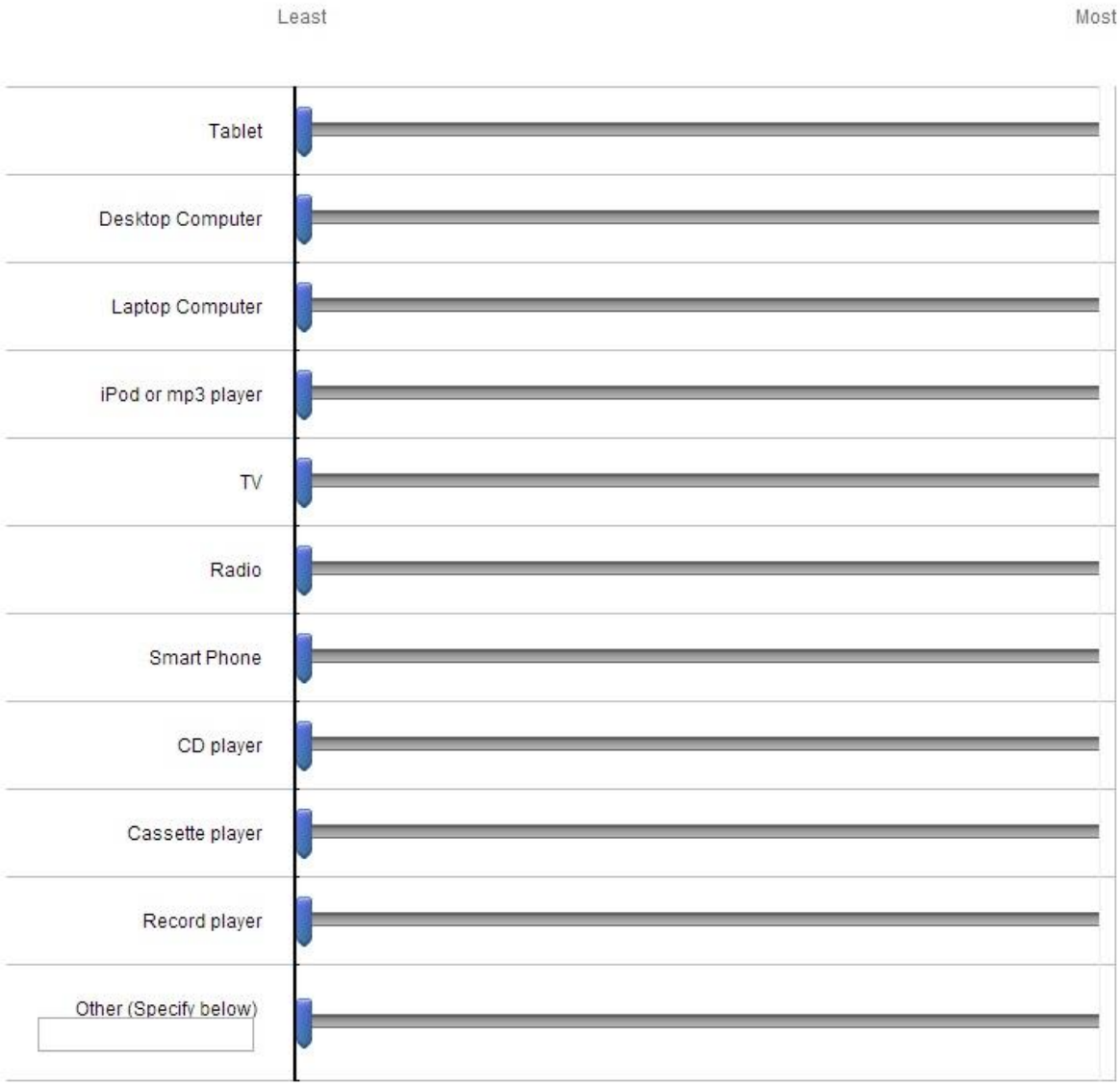
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

Hours

I listen to music while doing the following activities:



How often do you use the following devices to listen to music?



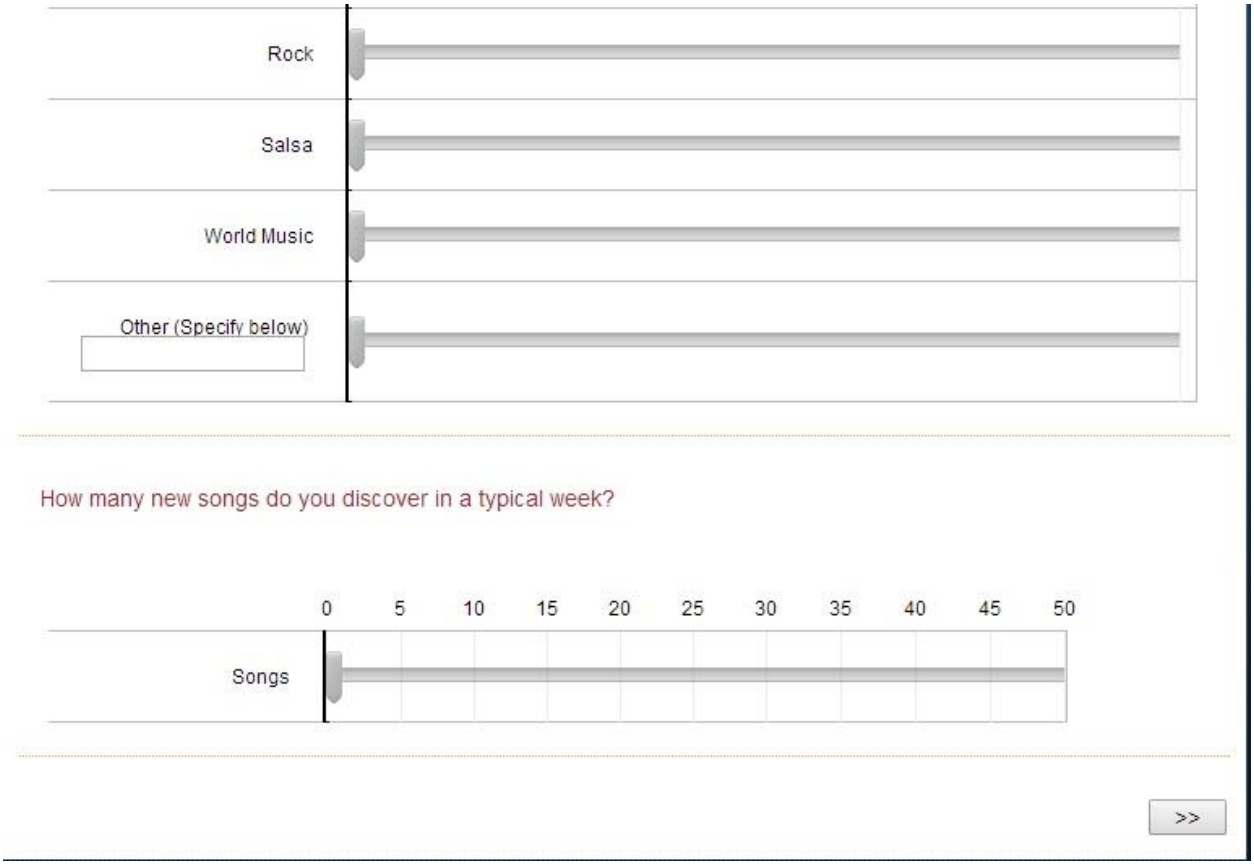
How often do you use the following services to listen to music?


Zune/Xbox Music
Rhapsody
Soundcloud
Vevo
Vimeo
Mog
Other (Specify below)

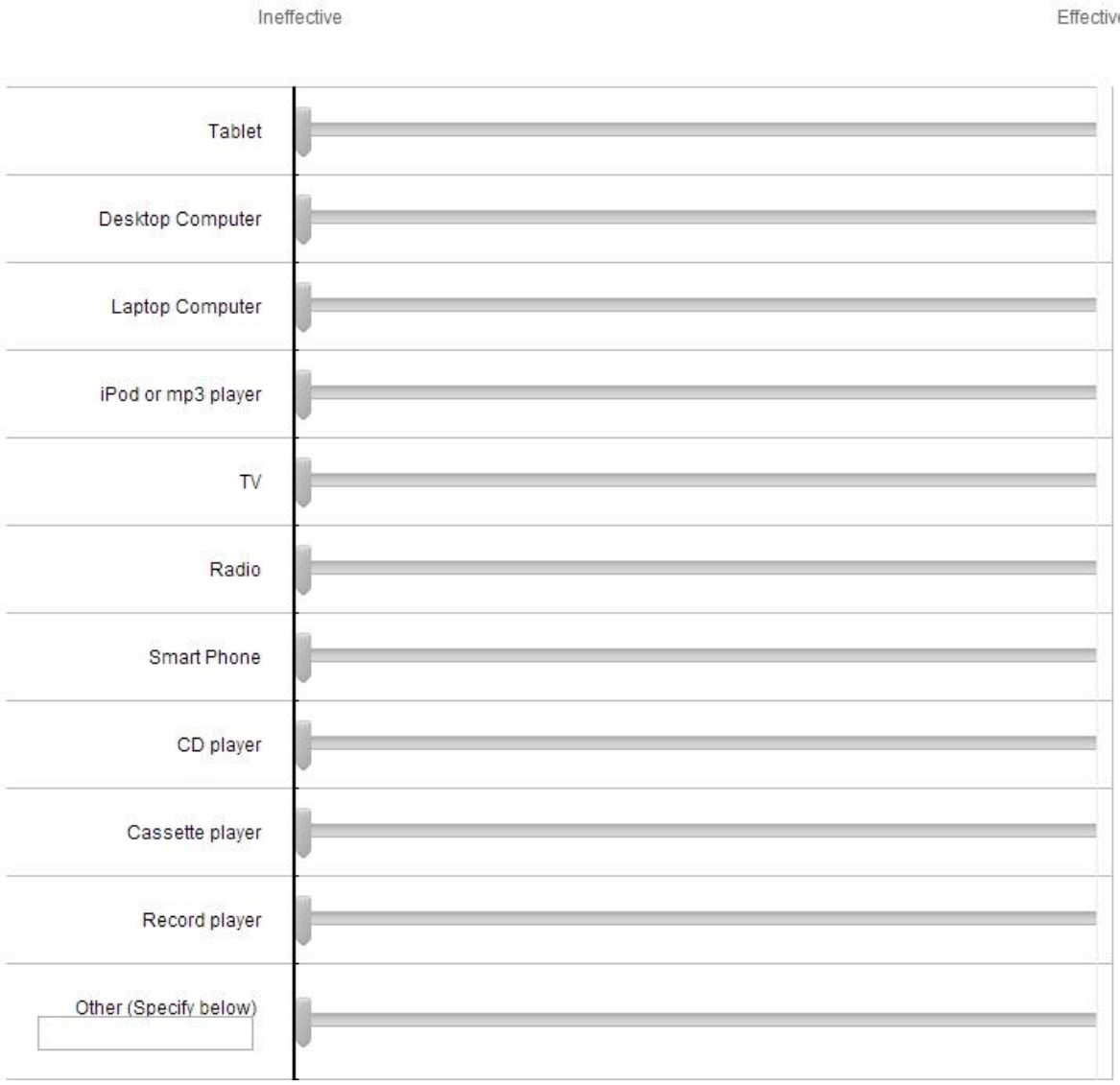
Rate how you feel about the following genres (5 stars being the highest):

Avante-Garde Experimental	☆☆☆☆☆
Blues	☆☆☆☆☆
Classical	☆☆☆☆☆
Country	☆☆☆☆☆
Electronic Dance Music	☆☆☆☆☆
Jazz	☆☆☆☆☆
Metal	☆☆☆☆☆
Pop	☆☆☆☆☆
R&B	☆☆☆☆☆
Rap/Hip Hop	☆☆☆☆☆
Rock	☆☆☆☆☆
Salsa	☆☆☆☆☆
Folk/Singer-Songwriter	☆☆☆☆☆
World Music	☆☆☆☆☆
Other (Specify)	☆☆☆☆☆

How often do you discover new music in the following genres (Including music that you don't like)?

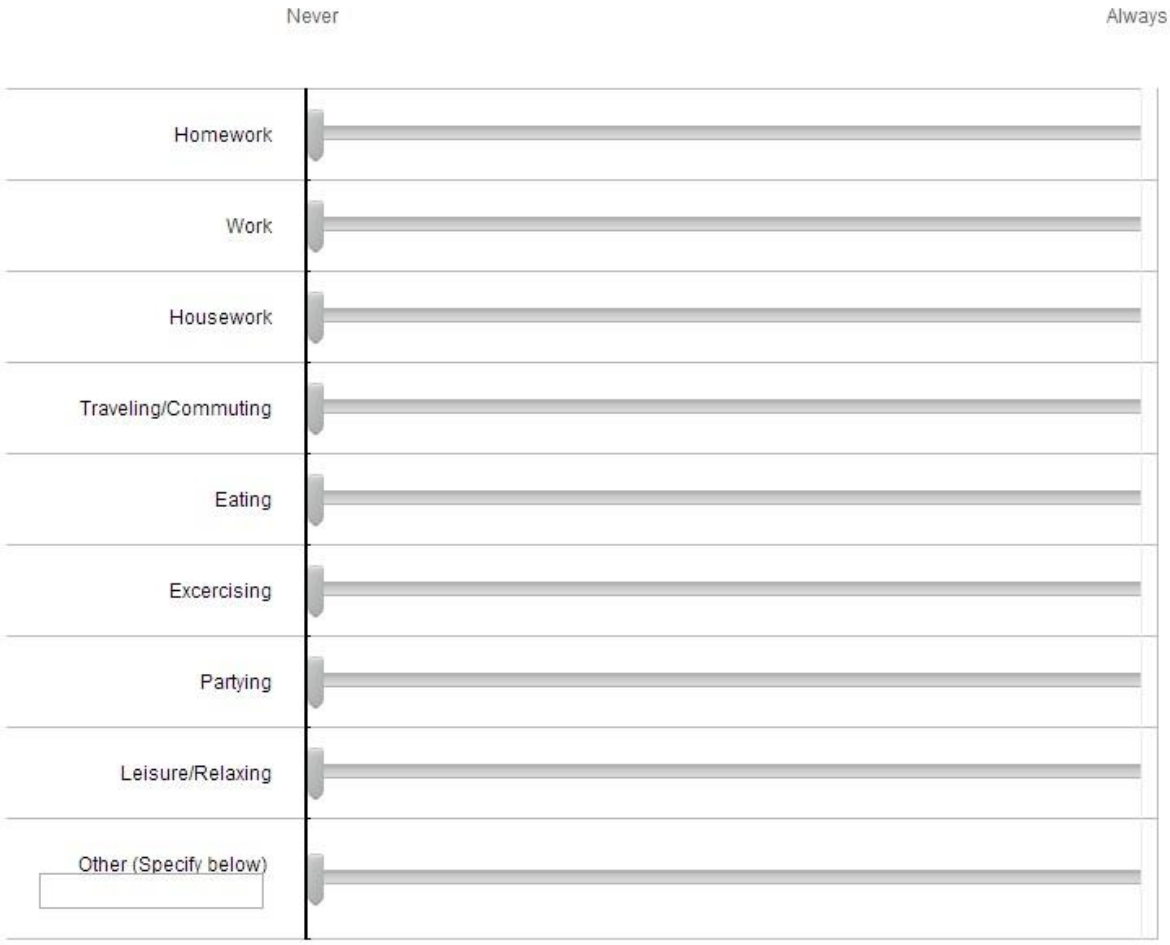

Rock
Salsa
World Music
Other (Specify below)
How many new songs do you discover in a typical week?
0 5 10 15 20 25 30 35 40 45 50
Songs
>>

How effective are the following devices for finding new music?



How effective are the following services for finding new music?

How frequently do you find new music when doing the following activities?



How often do you find new music in the following scenarios?

Never Always

Word of mouth

Looking for it

By chance

I find that music streaming services have made finding new music

Harder Easier

Since using music streaming services I find

- Less new music
- About the same amount of new music
- More new music

<< >>

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